The American

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(ILLUSTRATED.)

DEVOTED TO THE INTERESTS OF

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AND

GENERAL SCIENCE.

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(THIRTY-FIFTH YEAR.)

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REDMAN & KENNY, N.Y.

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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

CONTENTS.

An Asterisk (*) denotes an illustrated article.

OFFICIAL NOTICES—

Appointment of a Committee of Reception by the American Gas Light Association 1

The American Gas Light Association's Greeting to European Gas Engineers 1

EDITORIALS—

Briefly Told 1

The End of the First Half of '93.—The Midway Plaisance and the Lighting Thereof—Field's Analysis for 1892.

*The Inaugural Address Delivered by the President (Mr. Denny Lane, M.A.) at the Thirtieth Annual General Meeting of the Incorporated Gas Institute 2

*Abstracts from Proceedings of the British Royal Institution—No. II 6

Improved System of Working Inclined Retorts, by Mr. J. F. Braidwood 8

Some Account of the New Works of the San Francisco Gas Light Company 10

ITEMS OF INTEREST FROM VARIOUS LOCALITIES 11

Improvements on the Marlboro (Mass.) Plant—Mr. Somerville's Reply to "W. A. A."—Betterments at Canton, Ohio—Capital Stock Decreased at Jamestown, N. Y.—Proposed Ordinance Renewal at Kansas City, Mo.—Changes in the Staff at Montgomery, Ala.—Adding to the Plant at Brookline, Mass.—Proposed Opposition Company for New London, Conn.—The Lighting of the Broadway Cable Cars—The Opinion of the Gas Inspector of Omaha Respecting the Harris Process Gas—Cheaper Gas for Matawan, N. J.—Taxes Paid by the New Jersey Gas Companies—Annual Meeting, Quincy, Ills.—The Consolidation at Richmond, Ind.—Nonsuited at Toronto—The Patent Process Gas Man at Winona, Minn.—Cheaper Gas for Reading, Mass.—Cheaper Gas for Somerville, Mass.—And Other Items.

The Market for Gas Securities 14

[OFFICIAL NOTICE.]

Appointment of a Committee of Reception by the American Gas Light Association.

AMERICAN GAS LIGHT ASSOCIATION, OFFICE OF SECRETARY, PROVIDENCE, R. I., June 5th, 1893.

The following named members of this Association are appointed and respectfully requested to serve as a Committee of Reception, whose duty shall be to call upon all foreign gas engineers visiting our country during the continuance of the World's Fair at Chicago, whose names and addresses may be obtained, and to introduce them to other members of our profession, see that they obtain permits to visit the neighboring gas works and other objects of interest, and generally to make their stay in New York as pleasant as possible, and when they leave for Chicago, to give them letters of introduction to the Committee of Arrangements at Chicago: Messrs. Wm. Henry White (chairman), Eugene Vanderpool, William H. Bradley, Fred. S. Benson, William R. Beal, Thos. F. Rowland, Jr., Fred. W. Floyd and Oscar Weber.

The Guild of Gas Managers and the Society of Gas Lighting are respectfully requested to co-operate with this committee in extending hospitality to our visiting professional brethren.

A. E. BOARDMAN, President.

A. B. SLATER, JR., Secretary.

[OFFICIAL NOTICE.]

The American Gas Light Association's Greeting to European Gas Engineers.

AMERICAN GAS LIGHT ASSOCIATION, OFFICE OF SECRETARY, PROVIDENCE, R. I., June 5th, 1893.

To the European Gas Engineers—Greeting: The American Gas Light Association will hold its 21st annual convention in the city of Chicago, beginning on the date of Wednesday, October 18th, 1893. It would give the members of the Association great pleasure to meet there as many of the European gas engineers and managers as can make it convenient to be in attendance at the World's Fair at that time. It is suggested that all contemplating visiting the Fair arrange their visits so as to be in Chicago, if possible, at the time of this convention, when they will be most cordially welcomed by the Association and invited to attend the sittings of the body and participate in its discussions of papers presented.

Those engineers who cannot conveniently visit the World's Fair at that time, but must choose some other date, are respectfully requested to send their names and addresses, as soon as they arrive in America, to the AMERICAN GAS LIGHT JOURNAL, No. 32 Pine street, New York City, so that a committee from the Association may be made aware of their presence, and when they may be met, so that they may form the acquaintance of their professional brethren in this country and be made to feel less like a "stranger in a strange land."

A. E. BOARDMAN, President.

A. B. SLATER, JR., Secretary.

BRIEFLY TOLD.

THE END OF THE FIRST HALF OF '93.—This issue of the JOURNAL marks the commencement of our Fifty-ninth Volume, which brings to mind the fact that the first half of the current twelvemonth has gone into history; wherefore it may not be altogether unprofitable nor uninteresting to hark back a bit as to what was recorded in the period in respect to gas and its makers. Every one of the latter, and many of those who used their product as well, must vividly remember the rigors

of the opening months of the year, when high winds, extreme cold and heavy snows were the positive evidences of a winter season exceptional for its prolonged severity. These intemperate accompaniments of life in the temperate zone brought trial and temporary disaster to the gas makers of many States, and the effects of the frost were such as caused great loss and labor to the Companies and their Superintendents, and vexation to the consumers. Mains were broken, services were twisted and torn, meters were "frozen," and condensation was all too frequent; but perseverance, patience and "alcoholic spirit" finally won the day, and now the remembrance of the thousand-and-one complaints that "there is no gas" is taking on the indistinctness of a dream. The winter for the gas man, however, had some compensation, in that the severity of it, especially in larger cities, led many to warm up hall bedrooms and the like with portable gas heaters, and the dark days were so many and lengthy that the gas burner was put in duty early and kept in duty long. Summing it up, the verdict must be that incandescent electric lighting was not in the running last winter, and another odd thing about it was one did not hear so much about the disadvantages of gas as an illuminant because of the heat evolved during its combustion. There can be no doubt that the Companies throughout the country had a very profitable half year—the proof whereof we hope soon to submit to our readers in the shape of our semi-annual returns respecting output averages—for, as a rule, not only have the usual or customary dividend returns been made, but frequently the returns to shareholders have been increased. Notably is this so in New York city, where the Consolidated Company has raised its dividend rate to 8 per cent. per annum, and the Equitable Company found it possible to increase its dividend to a 12 per cent. rate. Perhaps the most convincing evidence of the stability of the gas industry, and of the belief of those financially interested in it that it will grow and spread, is seen in the general movement this spring towards enlarging and remodelling the manufacturing plants and in the planning for extending the main systems. We have actual record of 60 contracts entered into at as many different points for important works' betterments that call for an expenditure of close on to three millions of dollars, and in the lot it is seen that provision is being made for the additional daily storage of 40 millions cubic feet of gas. Another very healthful sign of progress is afforded in our item columns, where every week may be read announcements that this, that or the other Company has notified the people of the district concerned of a sensible reduction in the gas rate. From all quarters we are advised of continual demands on the gas men for gas cooking appliances, and it is an absolute fact that the several Companies in this city are unable to fairly keep up with the calls of this kind that are pouring in upon them. View it from whatever point one may, the only conclusion that can be reached is that the gas business of the country was never in better shape than it is at present.

THE MIDWAY PLAISANCE AND THE LIGHTING THEREOF.—One of the great features of the World's Fair is undoubtedly the strange, fantastic and generally alien aggregation located along the Midway Plaisance; but, unfortunately for those interested practically in the many hives that go to make up the aggregation, it is certainly not all profit with them, and chiefly because of the failure of the authorities in charge of the Fair as a whole to furnish the concessionnaires with a reliable article of illumination. Time and again the electric light, which is supplied by the companies which were granted a monopoly by the Fair Directors, has failed, and at the most inopportune times. A howling dervish, who does his bellowing in the dark, is not of much account as an attraction; neither is the Nautch girl of much account unless she can be seen as well as heard; and what does beauty amount to unless it may be scanned? However, the concessionnaires, tiring of being in the dark, have appealed *en masse* to the Fair Directors for a better lighting service, failing which guarantee they assert their willingness to put in and operate a plant of their own.

FIELD'S ANALYSIS FOR 1892.—We are in receipt of a copy of Field's Analysis, for 1892, of the accounts of the principal gas undertakings in England, Scotland and Ireland, which, as usual, is a brilliant testimonial to the abilities of its compiler (Mr. John W. Field) as an arrayer and digester of accounts. The book (the present volume is the 24th that has been issued) is so well known in this country, and its value as a document of reference to those who wish to keep posted in respect of the state of the gas business in the Kingdom of Great Britain is so well established, that any extended comment on it now would be but repeating that which we have said about it many times. The best praise we can give it is to say that the current volume is fully up to the standard of those that preceded it.

The Inaugural Address Delivered by the President (Mr. Denny Lane, M. A.) at the Thirtieth Annual General Meeting of the Incorporated Gas Institute.

Seven years have now run their round of days since you conferred on me the distinction of electing me to preside over our Institute. This distinction was no little enhanced by the facts that a body almost exclusively composed of engineers had chosen for its highest official one who was not a member of their profession; and that a society, nineteen-twentieths of whom were Englishmen and Scotchmen, had selected an Irishman to conduct their deliberations—a token, although a small, still a sincere, symbol of that amity which I trust may forever exist between these different nations. Then I felt not a little proud that, in London, I filled the chair which the Telfords, the Stephensons, the Brunels had as Presidents of a kindred Institution occupied—an Institution which, recognizing our kindred claims, had for many a year opened its hospitable doors for our reception. And now, as if the office of President was like the duration of Parliament, of a septennial character, it becomes my duty to open our proceedings in the industrial capital of Ireland.

When I was requested to accept this office, I was very unwilling to comply, feeling that I stood in the place of others more capable and more worthy; but when I understood that my election was unanimous, and that our meeting was to take place in Belfast, I could not resist the demand that an Irishman should greet you on his native soil, and wish you a hearty welcome when you came to visit "the fair hills of holy Ireland."

In other parts of our island you will see much to admire in natural beauty—the broad and grassy plains of our fertile midland, the bold cliffs of our coast (some of the highest in the world), the variety and majesty of our mountains, the beautiful courses of our rivers, the sheen of our lakes, embowered in foliage and ferns, nourished by the rains and dews of our humid and temperate climate; but it is only in Belfast and its neighborhood that you can see any large development of those great industrial enterprises which have done so much to maintain the population and increase the wealth of the sister countries. At a time when the woolen trade of the South of Ireland was suppressed by the jealousy of English manufacturers, the linen trade of the North was fostered until it grew into the position which it has for so long maintained; and the Irish linen trade, the largest in the world, maintained for so many years by the excellence of its quality, has its center where we are now assembled. The necessity for machinery called into play the energy of a large body of mechanics; not only for its own trade, but for that of the world, the spinning and weaving machinery of Belfast holds the first place. Another spinning industry—the production of cordage—is represented in Belfast by the largest manufactory in the world, and is administered by Mr. Smiles, who has learned from his father, the author of the "Lives of the Engineers," that lesson of "Self-help," which he so early and so zealously taught. Again, from the dockyards of Messrs. Harland & Wolff and others have been launched those rich commercial navies which count amongst their fleets some of the largest and swiftest vessels that ever swam on the ocean.

In selecting the topics on which to address you, a difficulty now exists which formerly was absent. The search for a subject with which you are not already perfectly familiar, every day becomes more embarrassing, from the fact that so many other societies—not only in London but in the Provinces—have during the course of the year discussed so many questions, and have been addressed by their Presidents on general topics so often, that nearly everything has been anticipated. I feel therefore like one who has arrived too late at a banquet, where all the best viands have been consumed, and only some crumbs of the feast are left to "coldly furnish forth the tables." Besides this you must remember that our meeting is held a month later than that of the kindred society; so that their able President, Mr. Methven, could gather the first-fruits of the year, and there was left for me only those topics which were turning sere. Indeed, little has been left unsaid on the practical details of our manufacture; and I have therefore thought it better to lead you away from your wonted fields into pastures new. On a previous occasion I took the same course, which seems to have met with your approval, and provoked one of the Continental journals into the most unmerited eulogy.

Within the now waning century three great developments have taken place, all from their magnitude necessarily co-operative—gas, railroads, electricity. I am not old enough to have stood by the cradle of the first, but I have travelled on the first passenger railways in England, France and Belgium, when I believe no others were open in the world. I saw the telegraph at work when it was open only from Paddington to Slough. I saw the earliest glow lamps, and heard some of the earliest

telephones. "Once upon a time there was a king, and he had three sons," so begin scores of fairy tales; and gas, the iron-way and electricity are the three "princes of the blood" whom the 19th century has engendered. I need not tell you that the eldest was and is, according to the story-tellers, the worst of characters, the second middling, and the youngest a paragon of all the virtues. Passing over the second prince, whose mediocrity condemns him to oblivion, let us study a little the characters of the vicious heir Gas, and the virtuous *frere cadet* of this royal house, entitled Electric Light. If the views I present seem too elementary to some of you, I have only to say I do not seek to teach those who know everything already, but rather to give a general view of the subject to such of you who have not had time to see both sides of the shield.

It may be thought that I cherish some prejudice against electric lighting. On the contrary, I have a most friendly feeling towards that mode of illumination, for since its advent the manufacture in which we are most interested has progressed more rapidly than at any former period. The company with which I am connected have more than once proposed to the local authority to take powers to supply the electric light, but the corporation has dissented. When properly managed, I believe the light is beautiful and convenient for those who can afford to pay for it; but no better evidence of its costliness can be found than that the west end clubs of London—the richest and most luxurious institutions in the world—signed not long since a "round robin," complaining of its high price. So far as we are concerned, the new light, instead of being a star of ill omen, has been the harbinger of success.

The figures I employ have been taken from those given by the electricians themselves. I wish that they would reciprocate this fairness, and, adopting our statements, imitate the "sweet reasonableness" which we proffer to them, and avoid the utterly unfounded statements about gas and its evil behavior, especially its deleterious effects upon health. I may give one case from my own experience. About 50 years ago, a professional friend of mine had gas introduced into every room of his house. Ten children were born there—the population running sometimes up to 16 persons. But no death took place except one—that of a lady no longer young; and it was never alleged that she was poisoned by gas. The disciples of Malthus should therefore wreck all the gas works they could reach, if this were generally the case.

The misstatements of some of the advocates of the new light are ludicrous. Several of them assume that we manufacture nothing but gas, and "remember to forget" that the raw material yields—in coke, tar and ammonia—products which often pay 75 and sometimes 100 per cent. of the prime cost of the coal. Again, they measure the light given by defective burners; but they allow no credit for good ones. If gas be burned in a bunsen burner, I can show that London gas does not reach a 1-candle standard; and most bad burners are modified bunsens, in which air is unduly mixed with gas. Again, they assume that an incandescent lamp retains its original power; while it has been proved that a 16-candle lamp declines to 8 candles, and averages only 12 candles. The Board of Trade was over-liberal to the new agent, when it allowed 10 units to be the equivalent of 1,000 cubic feet of gas. Practical men say 12 or 13 units would be more correct; and yet these one-sided advocates put down only 6 units as the equivalent.

In a recent paper on the "Economy of Electric Lighting," that eminent electrician, Mr. Gisbert Kapp, has pointed out that, when glow lamps are used at the power marked by the makers, it takes 4½ watts to give 1 candle. Indeed, the electricians themselves calculate that the 8-candle lamp requires 35 watts when new, or 4½ watts per nominal candle—a quantity largely increased as the lamps grow older. Now London gas gives per 1,000 cubic feet 3,300 candles, which, multiplied by 4½ watts, gives 14,300 watts, or over 14 units, without counting cost of lamp renewals, or the serious falling off in light-giving power. Allowing a small sum for the latter item, we may say 15 units are the equivalent of 1,000 cubic feet of gas; and at 8d. 15 units cost 10s., as against 2s. 9d. or 3s. When cannel gas is supplied, the contrast would be still more striking—over 20 units to 1,000 cubic feet. Mr. Kapp proposes to overwork the glow lamps, giving them a shorter life; believing that the extra cost of renewals will be more than compensated by the saving in current. These wilfully blind advocates shut their eyes to the fact that a gas burner may be checked in consumption, while the new lamp must be left full on or quite off—"Hobson's choice; this or none." From counting 16-candle they have come down to 8-candle lamps; and in other small ways they have endeavored to "whittle down" the comparative cost of the current. These statements often come from men whose names were never heard of in connection with electricity; and the authors of them might be pardoned on the theological ground of "invincible ignorance."

But, amongst them all, the boldest in reckless assertion is one who cannot plead such an excuse—Mr. Preece, the Electrician to the Post Office—a public official receiving a public salary as head of the Telegraphic Department. He has become the adviser of corporations and private companies, and the competitor of independent engineers who are not paid from the public purse. I will give you one example of his dignified style, taken from his inaugural address delivered to the Institution of Electrical Engineers last January. He says: "If a full load could be maintained during the whole 24 hours, electrical energy could be manufactured for one-third of a penny per supply unit, which is equivalent to gas at 2d. per 1,000 cubic feet. The potentiality of economy in electric lighting is thus beyond the dreams of the *gas man*. The most marked features in the development of this great industry are the ostrich-like blindness of the gas manager, who buries his foresight in his fat dividend, and the childish wailings of the gas technical journalists. The gas industry should itself have nursed the herculean infant who is rapidly strangling its main sources of profit." As one-third of a penny per unit is under a farthing per horse power, I can promise Mr. Preece to maintain his full load during the 24 hours when he is prepared to supply power at that rate.

"Save me from the evil spirit," exclaimed Paul Louis Courier, "and from *metaphors!*" Here in a small segment of a short paragraph you appear, gentlemen, as "dreamers," as "ostriches," as "puling babies," and as the "snakes" that the infant Herakles strangled in his cradle. But not only are these threadbare metaphors mixed one with t'other, but they are combined with the most ungracious language. You can determine how far it is consistent with the dignity of a gentleman, the culture of a scholar, or the *esprit de corps* of an engineer, to employ towards those whom he should regard as members of a kindred profession, terms which if meant for wit are devoid of humor, and if intended as contemptuous recoil on him who fell low enough to use them. The dignified periods of Samuel Johnson are combined with vulgarity; and if hereafter his dignified and potent shade will meet that of the Mercury of the English Post Office in Elysium, it will no longer be Elysium for the latter.

Mr. Preece proceeds to say that the "electric light is essentially the poor man's lamp," although I have already told you that in the district most densely packed with palatial hotels and luxurious clubs, which use the light for the longest hours, this poor man's lamp has been found too expensive for the very capital of clubland.

I will, with your permission, give some specimens of the "potentiality of wealth beyond the dreams of avarice," which Mr. Preece promises to those who embark with him on his voyage to El Dorado.

I will merely mention in passing, the London Electric Supply Corporation; but it would be unjust to reasonable electricians to compare their schemes with that of Mr. Ferranti. By Mr. Field's tables, the income of the three London Gas Companies is £1,724,000; while the capital is only £15,144,000, or 3½ times their annual revenue. The gas capital employed by eight large cities supplied by corporations is £8,015,000, or a little over four times their income of £1,978,000. Ten large provincial companies receive annually £1,725,000; while their capital is only £5,756,000, or 3½ times their revenue. The London Electric Supply Corporation in 1892 had an income of £24,282, with a capital of £836,000—equal to 34 years' revenue. This income, instead of increasing, was £4,400 less than that of 1891; and the expenditure exceeded it by £3,914, leaving a loss of this amount. Of the current generated, 58 per cent. was wasted in mains and transformers—leaving only 42 per cent. at the consumers' meters. But the distribution is now to be amended under the skilful guidance of Dr. Fleming; and the Directors hope that the "unaccounted-for" current will be reduced to 30 instead of 58 per cent. But even this reduced amount looks formidable enough to the eyes of a gas engineer. As a specimen of waste, I may mention that the outlay on instruments alone (exclusive of meters and transformers) was £12,000—not far from a half year's income—which would be much the same as if the Chartered Company were to spend £1,500,000 on pressure gauges, governors, photometers, etc. I think I may promise for Mr. Methven that he will not advise such an outlay.

I sincerely regret the evil fortune that has attended this great experiment, which seems to have been dogged by ill-luck from the commencement; but, even under the most favorable circumstances, success could not be expected for a design planned on such extravagant lines. It may have been "magnificent," like the Balaclava charge, but it was not a serious campaign. Mr. Ferranti—the general who set the squadrons in array—seems to have exercised a spell like witchcraft over the first Board of Directors. Now, under the financial management of Mr. Staats Forbes, I trust the affairs of the Company may improve, especially as at Deptford he is seconded by Mr. D'Alton, an able practical en-

gineer, who has already introduced valuable improvements, and has, moreover, the crowning virtue of being an *Irishman*, of a lineage which, to judge by my own experience, will not be without its value in your eyes.

But dismissing, for the present, this case of wild extravagance, let us see what the average result of such investments has been. That Cyclopædia of Science called the "Electrical Trades Directory for 1893," so admirably brought out by the publishers of the *Electrician*, is the latest authority I can refer to; but, as the campaign of 1892 was not closed when it was compiled, I must take the profits of the year 1891. From October, 1878, to 1882, 56 companies were floated, with a total capital of nearly 21 millions. More than half of this was paid up, and nearly all has been lost. At the close of 1892, the electric light companies of the Metropolis had a capital of £5,250,000, of which £2,700,000 had been paid up. The total profit for 1891 was £25,000, or less than 1 per cent. At the same time the electric manufacturing companies had a capital of £4,750,000, of which £2,700,000 had been called up, and earned a profit of £211,000 or nearly 8 per cent.—a fair, but still moderate profit on a fluctuating business. I have excluded the Edison-Swan Company, who only make lamps, and the Woodhouse & Rawson Company, which declared a dividend of 15 per cent., and were practically bankrupt the year after.

I will give an example of a town where gas and electricity have been in competition for over 10 years—Eastbourne—which has therefore the benefit of accumulated experience—an experience so valuable that the officials of the Electric Company wish to keep it all to themselves, for they have refused to give a copy of their balance sheet to a ratepayer who had contributed his quota to the public lamps which they supplied. This was a foolish attempt to conceal what could not be hidden. The total capital of the Company amounts to £37,000, of which only £400 is preference, on which, I believe, a dividend has been paid for some time; but this year the ordinary shareholders have for the first time been accorded a dividend. Charging 9d. per unit, the balance of profit and loss is £431, of which £233 is brought forward from a previous account; leaving the annual profit £198. But £169 of this arose from the sale of fittings; and £25 was received for a pupil's fee. If these two sums be deducted, we find the profit on electric lighting amounts to £4, for earning which the Directors justly received £250—too small a remuneration, when we consider the anxiety of mind caused by trying to navigate a craft so unseaworthy amidst shoals and breakers. They are now calling for more capital to be invested in this mine of gold, this "potentiality of wealth beyond the dreams of avarice," as Mr. Preece calls this "great industry." Why do the Directors not ask him to devote some of the abundant leisure which he has to spare from his official duties, and by his divining rod find this hidden vein of gold into which they have not yet sunk a shaft? In this same town of Eastbourne, when the electric light was started in 1882, the consumption of gas was 99,584,000 cubic feet; in 1887, 146,068,000 cubic feet; and in 1892, 207,036,000 cubic feet—an increase of 107,452,000 cubic feet, or over 107 per cent. Thus was this "spotted snake" strangled by the "Herculean infant." An old Cork rhyme runs thus:

It is better to fall with your back in a set of furze,
Than venture to play with those ticklish things *metaphors*—

rhyme *and* reason which I commend to Mr. Preece. I may remark that this Engineer has recommended the Corporation of Bristol to charge 6d. per unit; being 1,800 per cent. over what he says electricity could be supplied at, "if the load factor was uniform."

It is, I think, Mr. Crompton who first invented the very useful term *load factor*—meaning the ratio between the average and the maximum delivery of electricity. Of course, gas engineers have a load factor of a somewhat similar kind, but their system of storage enables them to put by the surplus of the day production to help the hours of darkness. With the alternating current, no storage is possible; and hence, if the dynamo ceases to work for even a few seconds only, all lights are extinguished. With the continuous system, accumulators afford a partial but a very expensive and wasteful remedy. If we put 100,000 feet of gas into a holder, and get only 85,000 out, we should say things were going on badly. Yet this very bad result is the very best claimed for storage cells, and in some cases the loss, I believe, is 40 per cent. The lot of the gas manager is also made more easy by the fact that a large percentage of gas is used by day for heating, cooking, motive power and manufacturing purposes, thus filling up, to some extent, the deep hollow of the electric diagram.

The sudden rise and the sudden fall of the curve produce the greatest difficulty which meets any system unprovided with storage power. Indeed, some of the statements under this head are startling. Professor Unwin states that within the 24 hours the demand varied from 4 times the mean to $\frac{1}{20}$ of the same quantity—that is to say, that the maximum was 80 times more than the minimum output. Even in gas distribution the maximum is 50 times as much as the minimum hour.

The latest authority is Professor Ayrton, who, in his monograph prepared for the British electrical section of the Chicago Exhibition, states that the average hours of consumption of the electric light in private houses is only 1 hour in the 24, in shops and flats only 1½, and that it is only clubs and theaters that exceed this limit. Let us see the result that this leads to. He says that the whole of the electric lights fixed in Great Britain are equal to 750,000 8-candle lamps. Allowing even 800,000 lamps, this would be equal to 400,000 16 candle lamps; and allowing even 1½ hours would mean 600,000 lamp hours, which could be supplied by 600,000 × 5 = 3,000,000 feet of gas a day, or equal to 1,100 million feet of gas in the year. This is less than the Brentford Gas Company sells. The town of Nottingham consumes more; and the combined consumption of Plymouth and Portsea is considerably more. The total sales of gas in London are 30,000 million cubic feet. The annual increase lately has been about 6 per cent., or 1,800 millions; so that the increase of gas consumption in London alone in one year would give 1½ times as much light as the whole electric lamps of Great Britain.

If we were situated near the Equator, the variation of the days would not be so great; and if we worked at night and slept by day, the load factor would be much more convenient for us all. Or, if we lived near the North Pole, we might work our dynamos for half the year, and let them sleep beneath the midnight sun for the other half. But placed as we are, where the seasons' change is so wide, this load factor becomes a burthen indeed. Make the case your own. Suppose that you had no gas storage, then in the lightest hour you should have as many retorts heated as may be required for the supply of the heaviest possible demand—for it is the *maximum hour's* consumption you should be prepared for; and in many cases the electrician has practically to provide, not for the maximum hour's, but for the maximum minute's output.

I have said that, besides the great aid that you derive from storage, your load factor is greatly alleviated and your feelings soothed by the fact that every year the "day" consumption of gas for heating, cooking, power and other manufacturing purposes increases, while the lot of our younger rival is not yet made happy by such consolatory aids. Mr. Methven, in his recent interesting address, has shown that in the district of the Chartered Company the consumption of gas from 6 A. M. to 6 P. M. has been 37 per cent of the total; and in other London districts a little under 30 per cent. Of course, we have heard of electric cooking, and I have seen the amusing experiments on this subject; but this and electric heating are reserved for that happy class "who have more money than they know what to do with."

Mr. J. Ferguson Bell, of Stafford, gives the following as the respective cost of 1 million heat units:

Gas at 2s. 3d. per 1,000 feet	40d.
Electricity at 4½d. per unit	1,301d.

The latter being 32 times as dear as heat produced by gas. Electric motors for very small powers will, I expect, come into use; but for anything above ¼ or 1 horse power, it is not likely that people will pay a price so much higher than gas power costs. On this subject I again refer to the authority of Mr. Bell, who gives the following figures:

Cost of gas power at 2s. 3d. = 0.675d., say ¾d. per horse power.
" electricity at 4½d. = 4.500d. per horse power, or say,
6⅔ times the price of gas power.

Let us now examine what modes have been proposed to get over this difficulty; and, at the outset, it is as well to say that no plan has ever been devised to store electricity itself. The garnering up of other forces forms the only mode of meeting the difficulty of the fat kine and the lean kine—of the brief harvest and the long winter. These forces have afterwards to be transformed into electricity.

First—to begin with the storage cell—no electricity is stored there. It is chemical energy which is laid up. If I take a piece of carbon and a piece of zinc, connected by a good conductor, and place them in an acid, well conducting and easily decomposed liquid, the zinc will first be oxidized; and the oxide so formed combining with the acid will form a soluble salt. When the zinc has all been dissolved, I place a second carbon in the solution and send through it a current of a strength sufficient to decompose the salt, when the metallic zinc will abandon the acid and be deposited on one of the carbons, leaving the free acid in solution. We have, therefore, what we began with—zinc, carbon and an acid solution; and, connecting the zinc and carbon as at first, we begin the series again, and repeat it as often as we like, the zinc being alternately oxidized and deodorized. This is precisely what occurs in the so-called storage battery. The lead compounds are alternately de-

oxidized and again oxidized, thus alternately absorbing and evolving a current. In both the cases referred to, the oxidation of the metal produces a current, and then an independent current produces deoxidation. As far as I can recollect, Sir William Grove, to whom science owes so much, was the inventor of the first storage system, which he called a "gas battery." A current was passed through two platinum plates and decomposed water—in fact, deoxidized hydrogen—the hydrogen and oxygen being collected in separate tubes. The battery wires were then removed, and the two platinum plates connected by a wire passing through a galvanometer, when a current was observed to be produced by the reoxidation of the hydrogen and the reconversion of the gases into water. Gaston Plante discovered that, by alternate oxidation and deoxidation of plain lead plates, similar effects were produced. Then came the innumerable forms of the Faure Sellon process, in which the

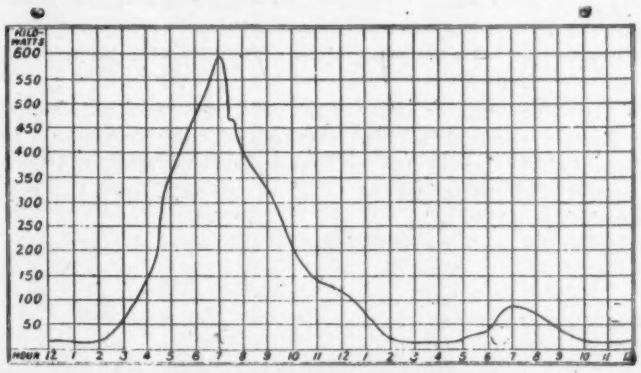
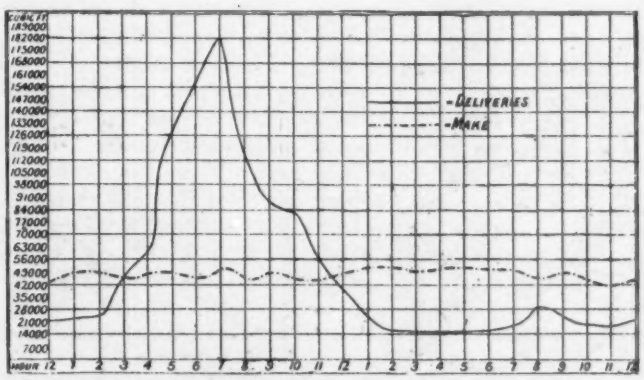


Diagram Showing Electricity Supplied from a Central Station in Midwinter.



Gas made in 24 hours, 1,174,000 cubic feet; do. delivered, 1,263,000 cubic feet.

Diagram Showing Make and Deliveries of Gas from the Cork Gas Works on Dec. 23, 1892.

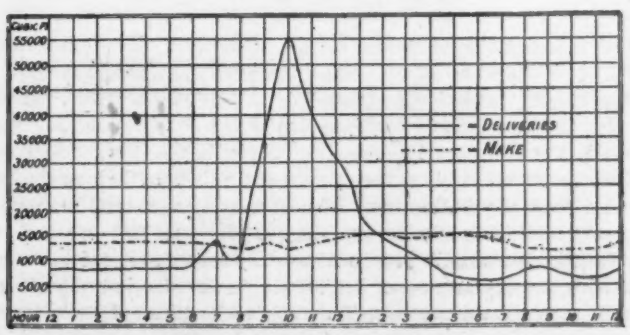


Diagram Showing Make and Deliveries of Gas from the Cork Gas Works on June 22, 1892.

lead plates were "pasted" with oxides of lead already formed. Yet I believe that, taking into account durability, no system has yet been invented better than the original Plante process, still surviving in the Howell-Crompton and other systems of accumulators. I have said so much in order to show clearly that in these cells there is no storage of electricity. Indeed, it would be wonderful if any prison could be designed to confine a spirit, not "airy," but far more subtle—in fact, "ethereal." As electricity has even disdained the chain of a definition, it does not seem likely that it will be "cabined, cribbed, confined" in any material cell. It passes the wit of man to devise the cunning cage that could confine such a wild bird. These storage cells are undoubtedly often of great use in supplying a small output during the hours of lowest consumption, leaving engines and dynamos at rest for many hours. They are also of use during the hours of heaviest duty, and particularly in steadying the current when the dynamos are running. They are, however, enormously expensive, and occupy a very large space; and I believe there have been explosions caused by the hydrogen evolved. Mr. Kapp, in his lecture at the Society of Arts, puts down their prime cost at £40 to £50 per kilowatt; and as 1,000 cubic feet of gas are equal to 30 kilowatts, we have thus £1,200 to £1,500 for storage, as against £12 10s. for gas. Mr. Kapp referred to comparatively small plants; and I believe for large central stations the capital would be less. But even if it were reduced to half, the cost of electric storage would be still 50 to 60 times as dear as gas storage. In addition, the depreciation is very heavy, and, with wear and tear, maintenance and interest, would sum up to 15 or 20 per cent. Their disadvantages are fourfold—

(1) Heavy outlay on capital.
(2) Very large space occupied.
(3) Heavy cost of maintenance.
(4) Loss of current, which, in the most favorable circumstances, amounts to 15, and is often over 40 per cent.

They can never be used economically, except as auxiliaries—a kind of very heavy dragoons, to guard the flanks of the main column.

Two other modes of storage have been recommended by very eminent professors, and nothing can more clearly emphasize the difficulty to be encountered than the fact that systems so complex, so expensive in construction, and so wasteful, should be even thought of.

Professor Forbes, having to deal with the case of Edinburgh—a place possessing for such a system natural advantages such as no other city in the British Islands enjoys—proposes to pump water for all the 24 hours, if necessary, to a reservoir situated at a great elevation, thus storing the potential energy of the elevated water. The water so stored is to actuate during the lighting hours turbines driving dynamos to produce the current. The natural advantage which Edinburgh possesses is this—that within 1¼ miles of the city it has, on Arthur's Seat, a natural reservoir at an elevation of 800 feet, and the capacity of this reservoir can be extended. As it exists at present, this reservoir can hold sufficient water to supply 1,000 horse power for two hours.

For motive purposes, the efficiency of a reservoir is the product of two factors—vertical height and capacity—the number of foot-pounds got by multiplying the elevation in feet by the number of pounds of water stored. Some strange mistakes have been made on this subject, and owners of water power have imagined that they have had what they called "a fine ponding power," when it really has been of very small amount. A good many years ago I devised the following very convenient formula, which some of my friends have associated with my name. In it I have assumed that the efficiency of the water motor is 75 per cent.—a very fair allowance when losses by friction, part-gate, etc., are taken into account. The formula is this: "One acre of water, 1 foot deep, gives 1 horse power for 1 hour for (each) 1 foot of fall."

This tells us at a glance how large the impounding reservoir must be unless the elevation be very great. Professor Forbes has therefore at Edinburgh the unusual good chance of a ready made reservoir at a very great elevation, and very near the city. Yet, under these circumstances, let us see what the losses may be, independently of the fuel used by the engine which drives the pumps.

First, the efficiency of the pumps themselves (including leakage of valves) cannot, I suppose, be higher than 85 per cent.; friction of rising main, which, being continuously at work, may be of smaller dimensions than the falling main, may cause a loss of 10 per cent.; for delivery main, say the same; efficiency of turbine, 75 per cent. Of course, I do not take account of efficiency of dynamo, which would be the same as if it were driven directly by steam engine. The ultimate efficiency would, therefore, be $.85 \times .90 \times .90 \times .75 = 51$ per cent. We should also count for interest and depreciation, say, 15 per cent. on the pumps and turbines, and 6 per cent. on the mains, and 5 per cent. on any outlay required for the extension of the impounding reservoir, besides rent and cost of "way leave."

Against this, the economies would be the cost of smaller steam engines (worked, however, for longer hours), and the saving of fuel lost in getting up and letting down steam. We have also to look to the additional contingencies which arise under this system. The bursting of a main, the break down of the pumps, the sticking of a valve, the choking of the turbines—any one of the these events would stop the supply of light. Even in the very favorable position of Edinburgh, I cannot see that this system commends itself to engineers.

[To be continued.]

AT a special meeting of the Directors of the Southbridge (Mass.) Gas and Electric Company a committee was appointed to prepare plans for enlarging the plant.

Abstracts from Proceedings of the British Royal Institution.

No. II.

On January 10, 1861, Dr. Tyndall* sent to the Royal Society as the subject matter of the Bakerian Lecture for that year, "The Absorption and Radiation of Heat by Gases and Vapors, and on the Physical Connection of Radiation, Absorption, and Conduction."† On January 18, in the lecture room of the Royal Institution, he exhibited experimentally to the members the salient points of his discoveries.‡ So that on this occasion the unwritten law, the Royal Society first, the public afterwards, was broken through. The precedent thus created has since been frequently followed.

The discourse commenced by a reference to the researches of Leslie, Forbes and Knoblauch, but more especially to the admirable investigations of Melloni on radiant heat. These eminent men had left the gaseous form of matter practically untouched.

Dr. Tyndall had great difficulty in the early stage of his investigation in securing a really good and accurate galvanometer, and great improvements in the construction of this indispensable instrument date from and are the outcome of his research.

It is a matter for regret that Dr. Tyndall's experiences have of late years been lost sight of, and that galvanometers are continually made having the chief defect he struggled to overcome—namely, that the astatic needles will not set themselves at true zero, but require to be drawn to it by a controlling magnet. The instrument, under this condition, of necessity suffers much in point of delicacy; indeed, accurate quantitative determinations are unattainable.

The wire of Dr. Tyndall's first instrument was drawn from copper obtained from a galvano-plastic manufactory in Berlin; but it was, nevertheless, not free from the magnetic metals. When the needles were perfectly astatic they deviated as much as 30° right and left of the neutral line. Through Mr. Becker he replaced this coil with one which reduced the lateral deflection from 30° to 3°.

But even this small residue was a great annoyance to him, and for a time he almost despaired. He knew that Professor Magnus had succeeded in obtaining a coil of pure copper wire for his galvanometer, but the labor of doing so was immense.§ Previous to undertaking a similar task the thought occurred to him that a magnet furnished an immediate and perfect test as to the quality of the wire. Pure copper is "diamagnetic," hence its repulsion or attraction by the magnet would at once declare its fitness or unfitness for use in a galvanometer.

Fragments of the wire from Berlin were strongly attracted by the magnet. The wire furnished by Mr. Becker, when covered with its green silk, was also attracted, but in a much feebler way. He removed the green silk and tested the naked wire. It was repelled! Some iron compound had been used in dying the silk, and to this the deviation of the needle from zero was due. Dr. Tyndall had the green coating removed and the wire overspun with white silk, "clean hands" being used in the process. A perfect galvanometer was the result. The needle when released from the action of a current returned accurately to zero, and was perfectly free from all magnetic action on the part of the coil. Nothing is more easy to be found than diamagnetic copper wire. Out of 11 specimens taken at random, 9 were diamagnetic, and only 2 magnetic. By the substitution of clean white silk for dyed silk, however large the coil may be, the compensator may be dispensed with, and a great augmentation of delicacy secured. In the form of galvanometer devised by Dr. Tyndall (N, Fig. 1), the needles are suspended independently of the shade, the latter being constructed so as to inclose the smallest possible amount of air, the disturbance of aerial currents being thereby practically avoided. The plane glass plate, which forms the cover of the instrument, is close to the needle, so that the position of the latter can be read off with ease and accuracy either by the naked eye or by a magnifying lens.

It is a well-known peculiarity of the galvanometer that its higher and lower degrees represent different amounts of calorific action. In the instrument above described it was found that the quantity of heat necessary to move the needle from 60° to 61° was about 20 times that required to move it from 11° to 12°.

In his experiments on radiation through air and other gases, Dr. Tyndall at first used a Leslie cube with water at such a temperature as to produce a deflection of 20° and 10° in succession, and then increased the heat till the deflection amounted to 40°, 50°, 60° and 70°, but in no case did the admission of air or any other gas produce any sensible change in the position of the needle. Now, in the case of the small deflections above referred to, the needle was, it is true, in a sensitive position; but then the total amount of heat passing through the tube was so inconsiderable that a small percentage of it, even if absorbed, might well escape detection. Hence arose the thought of operating, if possible, with large quantities of heat, while the needle intended to reveal its absorption should continue to occupy its position of maximum delicacy.

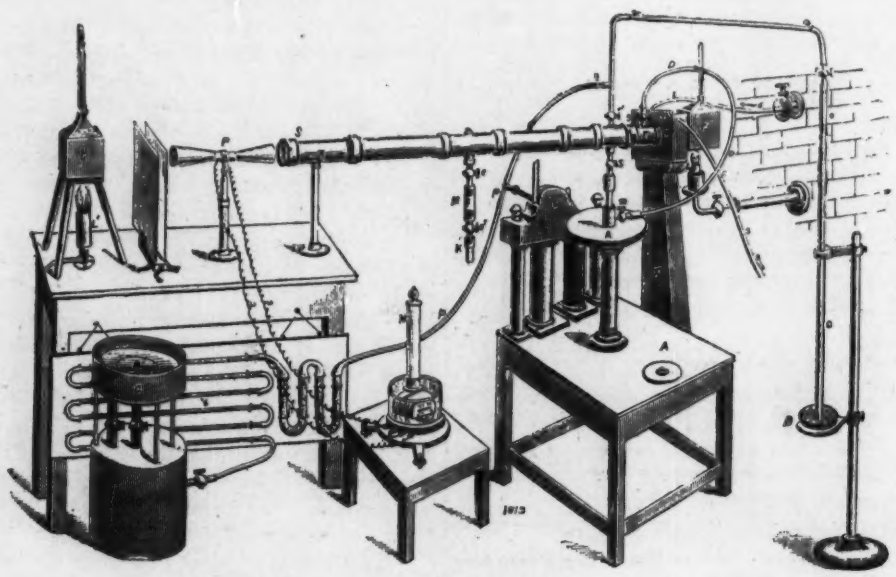


Fig. 1.

At first he used a differential galvanometer with two thermo-electric piles so excited in opposite directions that the galvanometer needle was at zero, with a ball of hot copper as the radiator. By these means he established the fact that air and gases did absorb radiant heat, but could not obtain exact measurements with so varying a source of heat as the copper ball. He resorted to copper cubes containing fusible metal, or oil raised to a high temperature, and finally had a lamp constructed which poured a sheet of gas flame along a plate of copper; to keep the flame constant a gas regulator was specially constructed for him by Mr. Hulet. It was also arranged that the radiating plate should form one of the walls of a chamber which could be connected with the air pump and exhausted, so that the heat emitted by the copper plate might cross a vacuum before entering the experimental tube. With this apparatus he determined approximately the absorption of 9 gases and 20 vapors.

The reason for making use of high sources of heat was that the ab-

* Although Professor of Natural Philosophy at the Royal Institution, and so designated in all official documents, John Tyndall was almost universally spoken of, and to, in the Royal Institution as Dr. Tyndall; whereas in his latter years Michael Faraday was spoken to as Mr. Faraday, and spoken of as Professor Faraday.

† The lecture was delivered on Feb. 7, and Published in the Philosophical Transactions, Vol. CLI., p. 1.

‡ Royal Institution Proceedings, Vol. III., p. 295.

§ "Philosophical Magazine," 1852, Vol. III., p. 82.

sorptive power of some of the gases examined was so small that to make it clearly evident a high temperature was essential. For other gases, and for all the vapors, a source of lower temperature would have been not only sufficient, but far preferable. Finally, Dr. Tyndall adopted boiling water as his source of heat, since, though it gave greatly diminished effects, it was capable of being preserved at so constant a temperature that deflections which, with the other sources, would be masked by the errors of observation, became with it true quantitative measures of absorption.

The entire apparatus made use of, and which was applied in the experiments of the evening, is shown in Fig. 1.* SS^1 is the experimental tube, composed of brass, polished within, and connected, as shown in the figure, with the air pump $A\,A$. At S and S^1 are the plates of rock salt which close the tube air tight. The length from S to S^1 is 4 feet. C is a cube containing boiling water, in which is immersed the thermometer t. The cube is of cast copper, and on one of its faces a projecting ring was cast, to which a brass tube of the same diameter as SS^1, and capable of being connected air-tight with the latter, was carefully soldered.

The face of the cube within the ring is the radiating plate, which is coated with lampblack. Thus between the cube C and the first plate of rock salt, there is a front chamber F connected with the air pump by the flexible tube $D\,D$, and capable of being exhausted independently of SS^1. To prevent the heat of conduction from reaching the plate of rock salt S, the tube F is caused to pass through a vessel V, being soldered to the latter where it enters it and issues from it. This vessel is supplied with a continuous flow of cold water through the influx tube $i\,i$, which dips to the bottom of the vessel; the water escapes through the efflux tube $e\,e$, and the continued circulation of the cold liquid completely intercepts the heat that would otherwise reach the plate S. The cube C is heated by the gas lamp L.

P is the thermo electric pile placed on its stand at the end of the experimental tube, and furnished with two conical reflectors, as shown in the figure.

C^1 is the "compensating cube" used to neutralize by its radiation the effect of the rays passing through SS^1. This device enabled Dr. Tyndall to dispense with the differential galvanometer. His thermo electric pile became the differential instrument.

The regulation of this neutralization was an operation of some delicacy. To effect it, the double screen H was connected with a winch and screw arrangement, by which it could be advanced or withdrawn through extremely minute spaces.

$N\,N$ is the galvanometer, with perfectly astatic needles, and perfectly non magnetic coil; it is connected with the pile P by the wires $w\,w$.

$Y\,Y$ is a system of six chloride of calcium tubes, each 32 inches long; R is a U-tube containing fragments of pumice stone, moistened with strong caustic potash; and Z is a second similar tube, containing fragments of pumice stone wetted with strong sulphuric acid. When drying only was aimed at, the potash tube was suppressed. When, on the contrary, as in the case of atmospheric air, both moisture and carbonic acid were to be removed, the potash tube was included.

$G\,G$ is a holder from which the gas to be experimented with was sent through the drying tubes, and thence through the pipe $p\,p$ into the experimental tube SS^1.

The mode of proceeding was as follows: The tube SS^1 and the chamber F being exhausted as perfectly as possible, the connection between them was intercepted by shutting off the cocks $m\,m^1$. The rays from the interior blackened surface of the cube C passed first across the vacuum F, then through the plate of rock salt S, traversed the experimental tube, crossed the second plate S^1, and being concentrated by the anterior conical reflector, impinged upon the adjacent face of the pile P. Meanwhile the rays from the hot cube C^1 fell upon the opposite face of the pile, and the position of the galvanometer needle declared at once which source was predominant. A movement of the screen H back or forward with the hand sufficed to establish an approximate equality; but to make the radiations perfectly equal, and thus bring the needle exactly to 0°, the fine motion of the screen above referred to was necessary.

The needle being at 0°, the gas to be examined was admitted into the tube, passing, in the first place, through the drying apparatus.

Any required quantity of the gas may be admitted, and here experiments on gases and vapors enjoy an advantage over those with liquids and solids—namely, the capability of changing the density at pleasure. When the required quantity of gas had been admitted, the galvanometer was observed, and from the deflection of the needle the absorption was accurately determined.

Up to about its 36th degree the degrees of the galvanometer used were all equal in value; that is to say, it required the same amount of heat to move the needle from 1° to 2° as to move it from 35° to 36°. Beyond this limit the degrees were equivalent to larger amounts of heat. Dr. Tyndall therefore calibrated the instrument by Melloni's method,* so that the precise value of its larger deflections was at once obtained by reference to a table. Up to the 36th degree, therefore, the simple deflections may be regarded as the expression of the absorption. Air of the laboratory dried and freed from carbonic acid, produced a deflection of 1°; oxygen, 1°; nitrogen, 1°; hydrogen, 1°. The total amount of heat transmitted through the tube in these experiments produced a deflection of 71.5. Taking as unit of heat the quantity necessary to cause the needle to move from 0° to 1°, the number of units expressed by the above deflection is 308. Hence the absorption by oxygen, nitrogen, hydrogen and atmospheric air of the calorific rays amounted to about 0.33 per cent.

This is the feeblest action which Dr. Tyndall observed. He made several hundred experiments with a view to range these gases in the order of their absorptive power, but was unable to do so with any certainty. Their proper action is so small that the slightest foreign impurity gives one a predominance over the other. An examination of the whole of the experiments induced Dr. Tyndall to regard hydrogen as the gas which exercises the lowest absorptive power.

Oxygen obtained from the electrolysis of water, and sent through a series of eight bulbs containing a strong solution of iodide of potassium, to remove any ozone, produced a deflection of about 1°. The iodide of potassium was afterwards suppressed, and the oxygen, plus its ozone, admitted into the tube; the deflection produced was 4°. Hence the small quantity of ozone which accompanied the oxygen in this case trebled the absorption of the oxygen itself.†

In juxtaposition with the above results Dr. Tyndall demonstrated the energetic action of olefiant gas (or ethylene, C_2H_4; density, 13.97). The needle being at zero, the admission of olefiant gas gave a permanent deflection of 70.3°. The gas being removed, and the equilibrium reestablished, a plate of polished metal was interposed between one of the faces of the pile and the source of heat adjacent. The total amount of heat passing through the exhausted tube produced a deflection of 75°. A deflection of 70.3° is equivalent to 290 units, and a deflection of 75° to 360 units; hence more than seven-ninths of the total heat was cut off by the olefiant gas, or about 81 per cent.

The extraordinary energy with which the needle was deflected when the olefiant gas was admitted into the tube, was such as might occur if the plates of rock salt had become suddenly covered with an opaque layer. Dr. Tyndall projected a stream of gas against the rock-salt disc for a considerable time; there was no dimness produced. The plates of rock salt removed daily from the tube usually appeared as bright as when put in. Neither was chilling an interfering cause. To subject the gas to ocular demonstration, he had a glass tube constructed and connected with the air pump. On permitting olefiant gas to enter it, not the slightest dimness or opacity was observed.

To remove the last trace of doubt as to the possible action of the olefiant gas on the plates of rock salt, the tin tube referred to at the commencement of these researches was perforated at its center and a cock inserted into it; the source of heat was at one end of the tube, and the thermo-electric pile at some distance from the other. The plates of salt were entirely abandoned, the tube being open at its ends, and consequently full of air. On allowing the olefiant gas to stream for a second or two into the tube through the central cock, the needle flew off and struck against its stops. It was held steadily for a considerable time between 80° and 90°.

A slow current of air sent through the tube gradually removed the gas, and the needle returned to zero.

Olefiant gas was admitted to the tube by turning the cock once half round as quickly as possible. The needle was driven in the first instance through an arc of 60°, and was held permanently at 50°. The quantity of gas which produced this effect, on being measured in a graduated tube, was found not to exceed one-sixth of a cubic inch in volume.

Dr. Tyndall then removed the tube altogether, and both sources of heat were allowed to act from some distance upon the thermo-electric pile. When the needle was at zero olefiant gas was allowed to issue from a common argand burner into the open air between one of the sources of heat and the pile. The gas was invisible, nothing could be seen in the air, but the needle immediately declared its presence, being driven through an arc of 41°.

* Philosophical Transactions, vol. cli, Plate I.

* Melloni, "Thermochrose," p. 59.

† Dr. Tyndall remarks that this result is in harmony with the supposition that ozone obtained in the manner described is a compound body, a supposition which later researches have converted into a certainty.

As up to this time natural philosophers had been taught to regard the transparent gases as almost perfectly diathermanous, the foregoing effects were witnessed with marked astonishment.

Dr. Tyndall himself was slow to believe it possible that a body so transparent to light as olefiant gas could be so densely opaque to any kind of calorific rays, and to secure himself against error made many hundred experiments before he announced its opacity to the scientific world as being due to true calorific absorption.

Having thus established in a general way the absorptive power of olefiant gas, Dr. Tyndall sought to establish a relation between the density of the gas and the quantity of heat extinguished. His first experiments failed to show any such relation.

An ordinary mercurial gauge was attached to the air pump; the experimental tube being exhausted and the needle of the galvanometer at zero, olefiant gas was admitted until it depressed the mercurial column 1 inch; the consequent deflection being noted, the gas was then admitted until a depression of 2 inches was observed, and thus the absorption effected by gas of 1 inch, 2 inches, 3 inches and more tension was determined.

Olefiant Gas.

Tension, in Inches.	Deflection.	Absorption.
1	56	90
2	58.2	123
3	59.3	142
4	60	157
5	60.5	168
6	61.0	177
7	61.4	182
8	61.7	186
9	62.0	190
10	62.2	192
20	66.0	227

Seven times the density gives about double the amount of absorption, whereas gas of 20 inch tension effects only two and a half times the absorption of gas possessing 1 inch of tension.

Olefiant gas of 1 inch tension producing so large a deflection as 56°, must extinguish a large proportion of the rays capable of being absorbed, hence the succeeding measures of gas, having a less and less amount of heat to act upon, produce a continually smaller effect.

Dr. Tyndall, in subsequent experiments, introduced an amount of gas so inconsiderable that the number of rays extinguished by it was a vanishing quantity compared with the total number capable of absorption.

O O, Fig. 1, is a graduated glass tube, the end of which dips into the basin of water *B*. The tube can be stopped above by means of the stopcock *r*; *d d* is a tube containing chloride of calcium. The tube *O O* being first filled with water to the cock *r*, had this water displaced by olefiant gas, and afterwards the tube *S S*^{1}, and the entire space between the cock *r* and the experimental tube, was exhausted. The cock *n* being now closed and *r*^{1} left open, the cock *r* at the top of the tube *O O* was carefully turned on and the gas permitted to enter the tube *S S*^{1} with extreme slowness. The water rose in *O O*, each of whose smallest divisions was equal to $\frac{1}{50}$th of a cubic inch. Successive measures of this capacity were admitted into the tube, and the absorption in each case determined. The table below shows that the absorption is under these conditions exactly proportional to the density. A double quantity of gas produces a double effect, a treble quantity a treble absorption, and so on.

Olefiant Gas. Unit measure, $\frac{1}{50}$th of a cubic inch.

Measures of Gas.	Absorption—Observed.	Absorption—Calculated.
1	2.2	2.2
2	4.5	4.4
3	6.6	6.6
4	8.8	8.8
5	11.0	11.0
6	12.0	13.2
7	14.8	15.4
8	16.3	17.6
9	19.8	19.8
10	22.0	22.0
11	24.0	24.2
12	25.4	26.4
13	29.0	28.6
14	30.2	29.8

The length of the experimental tube being 48 inches, and its diameter 2.4 inches, its volume is 218 cubic inches, Adding to this the contents of the cocks and other conduits which led to the tube, each $\frac{1}{50}$th of a cubic inch had to diffuse itself through a space of 220 cubic inches. The tension, therefore, of a single measure of the gas thus diffused would be about $\frac{1}{11000}$th of an atmosphere—a tension capable of depressing the mercurial column connected with the pump $\frac{1}{576}$th of an inch, or about $\frac{1}{15}$th of a millimeter.

Nevertheless, the absorption produced by this minute quantity of gas moved the index of the galvanometer through 2.2°.

Improved System of Working Inclined Retorts.

[A paper read by Mr. J. F. Braidwood before the Incorporated Institution of Gas Engineers.]

In 1890 it was decided to erect eight settings of inclined retorts at the Greenwich works of the South Metropolitan Gas Company, and an existing retort house was utilized for this purpose, some old arches having been pulled down to make room for the installation. Four of these settings were to be of the Coze pattern, 10 feet long, with 7 Ω-shaped retorts in each bench, and the other 4 were to be ordinary Ω-shaped retorts 15 feet long. It appeared to the author that if material saving in labor was to be effected it must be by placing a larger quantity of coal in the retorts, and that to do this effectually it was necessary to determine the inclination best suited for the purpose, the angle of 29½°, as adopted in the Coze design, being considered insufficient. In order to ascertain the most suitable angle, repeated experiments were made with one of the 15 feet retorts, and finally 36° was decided upon. In order to place the coal fairly in retorts set at this angle, the author was led to design his pneumatic charging machine, by means of which a steady flow of coal is continuously maintained. The angle of 36° having been determined upon, the main arches were built accordingly, a 14-inch ring being turned from the side walls to form a face for the work, and a starting point for the sloping main arch; and although it was anticipated that there would be considerable difficulty in building a row of arches at this inclination, this was not experienced.

It was decided to place 7 retorts in 1 arch, which was 9 feet 6 inches from wall to wall. The 15-feet retorts were supported by 6 9-inch intermediate walls, the back and front outside walls being 14-inch. The furnace used was one of the ordinary generator type, and almost exactly the same as that which had been successfully used at the East Greenwich works for heating settings of 10 retorts. It consists of a chamber 4 feet 6 inches long and 2 feet 2 inches wide, by 6 feet high, with 4 pieces of angle iron which form the fire bars, and which are placed at an inclination, in order to let a small stream of water run down each. The arch of the furnace is semi-circular, and one brick thick, and has equally distributed in the center 9 nostril holes, 3½ inches by 2 inches. At the sides of the furnace are placed secondary air flues, so arranged that the air is carried backwards and forwards three times, the object being to heat it somewhat before it enters the combustion chamber. From the top part of these secondary air flues are led, close down to the furnace arch, 9 outlets, so that the air is brought from either side to meet the gases issuing from the nostrils of the furnace. Combustion then takes place, the heated products travelling throughout the setting, and ultimately discharging into the main flue, which runs along the back of the setting just under the bottom retort.

Although these settings did fairly good work (having been almost continuously in action for the past two years), still the author did not consider them as satisfactory as he could wish; but the experience gained showed that by making considerable alterations very much greater economy in working, and more uniform heating, could be obtained. It was therefore decided to put up a further number of 14 settings of 6 retorts each, the main difference in these being that the center retort was done away with, and the size and shape of furnace were altered as follows: It was made 3 feet wide and 4 feet 6 inches long, the furnace arch being put in at two levels from end to end of the setting, while the setting was divided into two parts above the furnace arch. Two sets of secondary air flues were arranged on either side of the furnace to supply the back and front part of the setting, independently of each other, with secondary air, while the gases from the furnace were common to, and supplied, both arches. Each setting is also provided with 4 dampers, exclusive of the main dampers, so that the heat may be increased as desired at either front or back of the setting. Suitable mouthpieces have been bolted on at each end of the retorts, the top or charging mouthpiece being 20 inches by 15 inches, nearly oval in shape, and the bottom or discharging mouthpiece, to which the ascension pipe is attached, is 26 inches by 19½ inches, and, like the retort, is in shape a combination of an oval with a Ω. The retorts taper 2 inches in the length of 15 feet,

being 24 inches wide just inside the 14 inch work at the top, and 26 inches wide at the bottom. By this arrangement, although the angle has been reduced 2°, the drawing or discharging is very satisfactory indeed. Seven of these settings are now at work, and another 7 are in course of erection ; the charging machines, shoots, coal hopper, hoists, etc., in use with them being precisely of the same design as those used for the first section, the author having been, up to the present, unable to find any more convenient or suitable method.

The coal carbonized in these retorts is brought direct from the ships in trucks, and, by means of an hydraulic chain hoist, these are lifted on to rails at the top of a high-level hopper, where the coal can be distributed at any portion, by a man lifted with the trucks. At the bottom of this hopper are placed, at frequent intervals, small slides or doors, from which the coal is run into the chargers, which in their turn convey it to the top portion of the retorts. Thence, by means of a light sheet iron shoot running on wheels at the back of the setting, the coal is directed from the charging machine to the mouthpiece of the retort.

A brief description of the pneumatic chargers as designed by the author for working the retorts is as follows : On a strong, light, wrought-iron framework, mounted on 4 wheels, are placed 2 tilting tanks, carried on trunnions, and attached to the frame in front of each box is a shield or guide plate for the coal. In working this the bottom end of a portable shoot is first put into the mouthpiece to be charged ; the charger is then brought opposite, and the shield, being lowered on to the top of the shoot, forms a guide for the exact position of the charger, as also a guard to prevent any waste of coal. The attendant then pulls a rod at the back of the charger, which opens a door at the lower part of the front end, and at the same time, by means of a tappet on a rod, releases a catch, which allows the box to tilt slowly forward, the speed of tilting being regulated by an air cylinder placed in the framing of the charger, the piston rod of which is attached to the bottom of the tank. This piston regulates the speed of tilting as may be required, the result being that a steady flow of coal enters the shoot. The tank, when emptied, is drawn back to its place by the attendant, when the rod being released, it at once shuts the door and fastens the tank in position. The shield being then lifted, the truck is moved on to the next retort.

Before comparing the cost of working the inclined retorts with the most economical handwork on the old plan at Greenwich (which consists of settings of 7, 21 inches by 15 inches oval retorts, 22 feet long), it may be of interest to state the relative cost of erecting the two systems.

The expenditure for horizontal retorts, including main arches, stage, chimney, setting, etc., amounted to £44 10s. per 11-feet retort ; while the cost of the new inclined retorts, including overhead hopper, hydraulic lift, etc., works out £97 per 15 feet retort ; all labor and materials being included in both cases.

The cost of labor for working the two systems is as follows :

The wages of a gang working one side for horizontal retorts amounts to £3 12s. 6d. for 24 hours, during which time 27 tons 12 cwts. of coal are carbonized, this being equal to 31.63d. per ton, which includes all retort house labor. For working the new inclined retorts a gang attends to 7 settings, and the wages paid for all retort house labor for carbonizing 38 tons amounts to £2 8s. 6d., or 15.3d. per ton. This shows a difference of 16.33d. per ton in favor of the latter. Taking 56,527 tons, the total quantity of coal carbonized at Greenwich for 12 months, this would, at 31.63d. per ton (old system of handwork), amount to £7,449 15s. 9d.; but if the same amount had been carbonized by the inclined retorts, it would have cost only £3,603 11s. 11d. The saving effected in the carbonizing wages alone would thus be $3,846 3s. 10. As, however, these wages represent only the men who are actually employed in handling the coal and coke, there would be 5½d. per ton to be added to both, for pipe jumpers, flue cleaners, scurfers, lobby men, engine drivers, boiler firemen and foremen, which are included under the heading of "carbonizing wages." The total would therefore be, for handwork, £8,685 6s. 3d., or 36.88d. per ton, and for inclined retorts, £5,840 2s. 5d., or 20.55d. per ton.

Although the author has at present two-thirds of the total number of retorts at work on the inclined system, he has never worked them exclusively.

The figures given above show the saving in the wages alone ; but there is no doubt whatever that very considerable economy will be effected by the increased life of the settings, which will probably be double that of the old work before referred to. The author is also of opinion that where a proper system of inclined retorts is adopted there must be a very considerable benefit conferred both on the workmen employed and on the employer—so much heavy labor being entirely dispensed with.

The World's Petroleum Supply.

Petroleum is produced in various countries, either in its raw state springing from natural sources—as, for example, in the United States, Russia, Canada, Dutch East Indies, Austria, Roumania, Peru, Argentine Republic and Ecuador—or produced by the distillation of bituminous schist, as in Italy and France. Up to the present the United States has been the most important center of the petroleum production. The *Moniteur des Interets Materiels* says that the statistics establishing the yield during the last months of 1892 seem to indicate a gradual exhaustion of the sources, as the average daily supply in 1892 was only 87,711 gallons, compared with 94,980 gallons in 1891. On the other hand, the production of raw petroleum in 1891 and 1890 was respectively 34,000,000 and 45,000,000 barrels, or a falling off of 11,000,000 barrels in 1891. In spite of this the exports of petroleum, raw and refined, have followed, thanks to the employment of tank steamers, an ascending scale, and amounted to 740,905,237 gallons in 1892, as compared with 667,000,000 in 1891.

In spite of the diminished production, the prices, instead of rising, have experienced a fall, owing to the keen competition of Russian with American petroleum, hence the abandonment of certain springs in the United States.

At Baku, in Russia, the production is very great, and even exceeds the demand. No greater proof of this fact can be evinced than the low prices lately quoted, viz., one-half copeck per poud (36 pounds avoirdupois) for raw petroleum, and 7 copecks free on railway trucks for refined petroleum. During the first nine months of 1892 the production of raw petroleum in the Apsheron Peninsula amounted to 213,560,157 pouds, as compared with 213,056,000 pouds for the corresponding period of 1891.

The present depressed condition of the petroleum market in Russia will be improved, it is expected, by the formation of the syndicate that has been constituted by the several principal producers of petroleum at Baku under the presidency of M. M. Noble freres.

With respect to petroleum production at Baku, Mr. P. Stevens, Her Majesty's counsel at Batoum, in a report to the Foreign Office, dated the 1st of March, states that an oil well has recently commenced to flow at Baku, which, at its present rate of production, considerably exceeds the daily output of all the largest wells that have hitherto been in activity in the Apsheron Peninsula.

It is estimated that the well in question is delivering, as near as possible, 1,000,000 pouds, or 17,742 tons of crude oil a day ; but owing to the almost insurmountable difficulties experienced in getting a flow of this magnitude under control, most of the oil is running to waste into an adjoining lake known by the name of Romani.

The well is situated one-fourth to one-half mile further eastward on the peninsula than any of the other wells, and, it would appear, opens up a fresh territory comprising several hundred acres of land from which no oil has yet been extracted.

From the point of view of the importance of the production, the petroleum supplies of Canada take the third place. From the 1st of January to the 30th of November, 1891, 192,700 barrels of raw petroleum and 248,025 barrels of refined were exported. During the same period of 1892 these shipments amounted to 182,371 and 279,823 barrels respectively, a total production in the first 11 months of 1891 equivalent to 805,687 barrels of raw petroleum, and in 1892 to 917,561 barrels.

Petroleum has been found in Quebec, Nova Scotia and New Brunswick, and particularly in the Northwest Territories, where it seems certain that there is an immense unexplored oil region. It is, however, in the county of Lambton, whence most of the oil has been, and still is, obtained. The township of Enniskillen is one of the largest oil producing districts, and the oil is obtained there at a depth of from 370 to 500 feet. The first flowing well was struck in February, 1862, and before October of the same year there were no less than 35 wells. As there was no accommodation for the storage of this enormous flow, there was a frightful amount of waste, and it is calculated by one authority that between the dates mentioned no less than 5,000,000 barrels of oil floated off upon the water of a neighboring creek.

The petroleum supplies of the island of Sumatra have only recently been exploited. The product of one district amounted to 20,000 10-gallon boxes in a year. According to the most recent analyses (*vide C.T.J.*, No. 306, p. 210) the Langkat petroleums are of excellent quality, and moreover they are derived from lands the extent of which is 40 times greater than those in Russia.

According to official statistics, published by the Austrian Minister of Agriculture, there were in Galicia, in the year 181, 1891 establishments engaged in the production of petroleum, and 79 ozokerite mines, sup-

plying together a total quantity of 93,875 tons, of an estimated value of £491,000.

In Italy and France petroleum is obtained by the distillation of bituminous schist. In 1891 the Italian production was 1,155 tons of petroleum, while in France the amount of the product for 1889 was 194,000, as compared with 174,000 in 1888.

The yield in Roumania barely attains a value of £2,400, although this amount might easily be increased, seeing that there are vast numbers of beds from which it can be obtained, and that the oil itself is of excellent quality. The explanation of the small supply lies in the fact that the government insists, in the case of crown lands, upon the payment of a royalty immediately upon the signing of the contract, and even before any petroleum has been found.

The petroleum beds in Peru are of vast extent and are beginning to attain considerable importance. The London and Pacific Petroleum Company has works extending over a distance of two miles along the coast, and owns 26 pits which are in working, having a depth of from 70 to 500 feet, and producing 900 barrels a day.

In the Argentine Republic, 12 pits have been sunk in the department of Lujan, province of Mendoza, of which three have yielded excellent results. The Company working these mines since 1890 has produced about 1,500 tons of petroleum.

At Cachenta, in the province of Mendoza, in the Argentine, a considerable petroleum industry has sprung up during the last two years. In this district there is a promise of great mineral wealth, but as yet it has been worked only in a desultory manner. There seems to be a future before the petroleum industry. Up to the present time three successful borings have been made, and the total output since the first boring, 1890, has been 1,500 tons. The oil is conducted through pipes to the storage tanks at San Vincente. It finds a ready sale at the Rio Cuarto and Mendoza gas works and at the Argentine Great Western Railroad. This railroad has 12 locomotives which use the oil as fuel.

In the Republic of Ecuador numerous petroleum beds are known to exist, and these are of considerable extent. In certain places the oil springs from the ground and forms pools and streams, which eventually find their way into the sea. A syndicate has recently been formed with the object of obtaining the concession of these sources of petroleum, the product of which is said to be of very good quality.

In British Burma it appears that there are now 602 petroleum wells, an increase of 92 since 1888, but there are distinct signs of exhaustion. The fact that the aggregate production of the richer wells has fallen off, while that of the poorer ones has increased, although many new wells have been opened, is regarded as the surest indication of the approaching decline of the industry. The drilled wells worked by the Burma Oil Company and the Burma Oil Syndicate have given very satisfactory results. In 1890 the total out-turn amounted to over 3,670,000 viss; but the rate of progress during 1888, 1889 and 1890 has not been maintained during the past two years. The history of the industry shows that the production of the oil field steadily increased from the beginning of the century until about 1873, when it began to decline, rising again in 1885 and coming practically to a standstill in 1891.

Some Account of the New Works of the San Francisco Gas Light Company.

The following description of the new works of the San Francisco Gas Light Company, located at the foot of Buchanan street, and some comments on the practice of the Company in respect to the introduction of gas cookers and heaters, originally appeared in the columns of the San Francisco *Bulletin:*

Two subjects are largely occupying the time and attention of the San Francisco Gas Light Company and its officers at the present moment. One of these is the increase of its supply and the improvement of the quality of the gas furnished to the people of this city. The other is the more general utilization of gas for cooking and heating purposes. Both of these objects are in course of attainment, and both are of sufficient interest to the public to justify a description of the new plant at North Beach, and an explanation of the advantages of gas over grosser fuel for procuring artificial warmth and preparing the repasts of the family.

Several years ago the fact became patent to the Company that it would have to erect larger and more modern works, and a location covering five blocks of land was purchased on the bay front, immediately west of Fort Mason Reservation. It was then decided that two plants should be placed in operation, one for the manufacture of water gas and the other for making coal gas. The first of these is completed; the other will be finished before the close of the year.

The coal gas produced in the new works with these modern devices will be of better quality than is possible from the old plant, which, after many years of service, will require renovation and remodeling. On the other hand, the conditions of the manufacture of water gas are such that the supply can be better adjusted to variations from its normal demand than is the case with the coal product. It is for this reason that the combined plant was resolved upon, with a capacity of 3,800,000 cubic feet of gas every 24 hours.

Consumers will not be supplied with either the coal or the water gas alone, but of a blending of the two in nearly equal proportions, as experience has shown this to give the best results to the consumer. The water gas plant has a daily capacity of 2,000,000 cubic feet, and the coal gas plant is to have one of 1,800,000 cubic feet per diem.

The effect produced on the visitor after having gone through the new works is the convenience of the arrangements, the high finish of the buildings, the airiness, lightness and cleanliness of the surroundings, and the great care which has been taken to provide for the safety and comfort of the employees. Another point is that everything is of home production. The varied material for the buildings, the boilers, generators, purifiers, and other machinery were all made in San Francisco, and the money which has been invested in this great plant has found its way to the manufacturers and workingmen of this city, and through them into all branches of local business and trade.

Indeed, so great was the desire of the San Francisco Gas Light Company that this course should be rigidly adhered to, that when it came to contracting for the great 2,000,000 cubic feet gasholder it was found necessary to have special detailed plans prepared. Nothing of the magnitude has been before attempted here, and the amount of work, the nicety of calculation and the infinite amount of detail required can only be appreciated by those who have gone carefully through the drawings.

The principal buildings at the new works are the retort house, generator house, the purifying house, the meter house and the exhauster building. All are substantially constructed of brick and iron, with cement flooring, and in some instances with handsome wood finishing. The retort building will be used for the production of coal gas. When completed it will be furnished with 20 Weber benches of 9 retorts each of the latest regenerative furnace. It will also contain a hot tar scrubber, that is to say, a device for eliminating all tar from the gas before it goes to the condenser.

The building is a solid structure of brick, with corrugated iron roof, and when completed will have two floors, also of iron. Its dimensions are 180 feet by 74 feet. The generator room is nearly as large, being 182 feet long by 64 feet wide. It, too, is absolutely fireproof. The generators, like all else in the plant, are of the latest pattern. A noticeable feature of the apparatus is the oil vaporizer, used in the manufacture of water gas. It is the Company's own invention. By it the oil is taken and fed from the storage tank, and, after passing through the vaporizer, is delivered at the generators in the form of vapor at a temperature of 300°, ready to be blended with the gas. Another device is an automatic oil feeder. The top lid of the generators is connected with the main water supply to the condensers, so that the water is used only when gas is being made. Everything is so arranged that one man can operate two generators at once.

In the exhaust room are 4 exhausters, with engines on same bedplate, a tubular condenser, a tubular scrubber and a Standard scrubber. In this building lockers and lavatories have been provided for employees. The purifying house is admirably arranged for the removal of sulphur and other deleterious substances from the gas. Here a system has been installed for the revivifying of the oxide of iron, after use, without removing it from the boxes, a great gain in time, labor and expense. Beneath each purifying box is a steam jet exhauster which draws down the air through the oxide of iron, thereby rendering it fit for use in a few hours. Under the old system of shoveling out, from two to six days were necessary for the revival process. The meter house, apart from the purpose which its name implies, will contain sleeping and eating rooms for the chief and assistant engineers, as well as other officers, when their duties shall require their continued presence at the works. One point in connection with the plant which should not be overlooked, for it is of great practical importance, is that everything is above ground. It is thus safe and easy to watch and control the gas currents at all of their various stages. Last, but far from least, the mammoth gas tank demands attention. It is the largest affair of its kind on this coast and one of the biggest in the United States. Its capacity is 2,000,000 cubic feet, or nearly equal to the other seven gasometers of the Company combined. The holder is in three sections and is telescopic, rising to the extreme height of the frame, or 108 feet. It is sunk in a pit 38 feet below the grade of Bay street, and is surrounded by a brick

and cement wall, rising to a few feet above the level of the ground. From the top rail to the bottom of the tank the distance is 146 feet. The dimensions of the great holder itself are 163 feet diameter and 37 feet depth. The plans for the great combined water and coal gas plant were all made by President and Chief Engineer Crockett, and are being carried into execution by E. C. Jones, the assistant engineer. The improvements are many and varied and cannot fail to benefit the gas consumers of San Francisco.

Attention is next directed to the gas stove department, a very interesting one to heads of families, to housewives and to occupants of offices, and one in which great interest is taken by the Gas Company. So convinced is it of the many advantages which gas stoves and grates have over those in which coal is used that it has established a large and well appointed depot at 16 Post street, where all styles of these heaters and cookers are supplied to the public at the minimum price. The rapidly increasing popularity of the gas stoves is not due to caprice, but to many substantial reasons. They are cleaner than their coal rivals.

No dirty fuel is required and there is no poking, no ashes, no soot, no smoke and no sparks. They are time-savers; the required heat is obtained in a few minutes, and an hour or two are thereby gained every day in the kitchen. They are more economical; the cost of the gas is 50 per cent. less than the coal, as has been proven by actual experiment. The fuel gas differs in some respects from the illuminating gas. It is taken from the same pipes, but by the intervention of the Bunsen burner in the case of the former air is mingled with the gas, thereby increasing its caloric power over one-quarter.

The fuel gas consists of 1 part of illuminating gas to 7 parts of air; thus, in round numbers, 1,000 feet of ordinary illuminating gas will furnish the equivalent of 8,000 feet of fuel gas. This is a point which should be well kept in mind. It explains why the fuel gas is not an expensive luxury. Take one of these gas stoves in actual operation.

The air is automatically mixed with the gas. This renders the latter odorless as the combustion is complete. Underneath the aperture through which the gas passes from the gas cock are large openings which allow the air to rush in freely and form with the gas a vapor which when ignited emits a flame of dark-blueish hue. Now, for the sake of experiment, close the air holes. What is the result? At once the gas is seen to burn in a yellowish white flame. That proves that by mingling with the air the entire nature of the gas is changed.

It becomes a caloric rather than an illuminating agent. That the desired heat can be obtained in these gas stoves, and that speedily, economically and safely, has been set forth. The next point, and that which especially interests the occupant of the dining room is this: Does the gas stove affect the taste or change the character of the food cooked upon it? Experiments, confirmed by the highest scientific authority, furnish the answer. They prove that meats prepared with fuel gas yield a return of at least 20 per cent. more nutriment, and that besides this gain meats and other food are rendered more palatable, more easily digestible, and therefore more healthful than those cooked with ordinary coal or wood stoves or ranges. With the gas stoves the meats are broiled from above, and the juices which would otherwise escape in the fire are caught in a dripping pan, while on the other hand they are roasted as in a Dutch oven instead of being merely baked as in the coal appliance.

The assortment of gas stoves at 16 Post street is astonishing to those who have never studied the practicability of gas fuel in the kitchen. They run from the neat little portable heater, through family stoves of different capacities, to the hotel range, capable of cooking a substantial meal for from 50 to 75 persons. In fact, there are numerous attractive appliances for all kinds of uses. For instance, there are broilers for restaurants, heating irons for tailors, laundries, hair dressers, etc.; there are gas stoves of all kinds, description and sizes, capable of baking, roasting, broiling, toasting, boiling and frying, and even with boiler attachments for dish washing and bathing purposes. Nothing that a coal stove can do is the gas stove unable to perform much better, much cheaper, without dirt and with a great saving of time.

The kitchen is only a part of the realm of coal and wood which gas fuel has invaded and is making its own. The matter of heating living and working apartments is as important as is that of cooking. The high heating power of fuel gas and the safe and efficient apparatus for its use are unequaled. Grates and stoves are fast being replaced by gas radiators. Their use obviates the necessity of carrying coal and wood into the parlor and the bedroom, and effectually does away with the ash nuisance, so destructive of carpets and so annoying to the careful housewife. The gas grate is lighted in a moment, and in a few minutes it begins to throw out its heat, which can be regulated by a turn of the hand. Many of them are artistic in design, and are an ornament as well as an article of use in the parlor or sitting room.

Their adoption is becoming general in offices, stores, hotels, schools and workshops, as well as in private homes, and as their many advantages and conveniences become better known the demand for them is steadily increasing. The Gas Light Company is doing all that is possible to render their use, as well as that of the gas kitchen stove, more popular. Every attention is paid to the visitor at the rooms, situated at 16 Post street. The fullest examination of the various styles of stoves and grates are given, with practical exemplifications of their workings. The same liberal policy is pursued by the Company in the matter of sales and the placing of the apparatus. No profit is sought to be made. The sole object is to educate the people to the advantages of the use of gas fuel, its convenience, its economy, its saving of time, freeness from annoyance and general good results. In this it has been eminently successful.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

"G. F. M.," writing to the JOURNAL from Marlboro, Mass., says: "The Marlboro Gas Light Company has awarded the contract for a new gasholder to Messrs. Davis & Farnum, of Waltham, Mass. The brickwork on same structure has been allotted to Mr. W. S. Frost, of Marlboro. The other buildings, the plans for which are not fully completed, will house carbonizing, condensing, purifying and measuring apparatus, capable of sending out 200,000 cubic feet of gas each 24 hours." Of course, all this work is under the immediate direction of the Company's Superintendent and Manager, Mr. George F. Macmun, who asserts that everything will be finished and in working order early in the fall.

THE following reply to "W. A. A.'s" query, published in our "Item" columns for June 19th, ought to be convincing:

ENGINEER'S OFFICE, INDIANAPOLIS GAS CO.,
Indianapolis, Ind., June 21, 1893.

To the Editor AMERICAN GAS LIGHT JOURNAL: Your correspondent, "W. A. A.," in the last issue of the JOURNAL, seems to express some doubt as to the correctness of my statement that an old meter placed on the supply pipe of a gas engine will prevent oscillation. It seems to me the best way to find out would be to try it. Let him set the meter between the engine and the pipe which supplies the lights. Let the capacity of the meter be larger than that required to run the engine and remove the index. He will find that the old meter will act as an elastic reservoir, and will prevent oscillation.—Yours very truly, JAS. SOMERVILLE.

SOME days ago the Syracuse (N. Y.) *Standard* published a table of gas rates in various cities throughout the country, and in commenting thereon said: "The local Gas Company enjoys an exclusive field in Syracuse, but, to its honor be it said, it has never attempted to assert the prerogatives of a monopoly. The business it carries on represents the investment of local capital, and the management of the Company being in the hands of citizens immediately interested in the progress of the city, has invariably adjusted the tariff of rates on an equitable basis, having always in mind, apparently, the fact that the Company was dealing in one of the necessaries of life, to unduly increase the cost of which is to stifle growth in population and warn off new enterprise. The Gas Company has also shown its concern for the city's welfare in the use it has been permitted to make of the streets. No corporation in Syracuse has ever pretended to restore highways disturbed as conscientiously as the Gas Company. Its workmen are more careful even than the employees of the city."

THE plant of the St. Charles (Mo.) Gas Light and Coal Company will be sold at public auction, to the highest bidder, without recourse, at 11 A. M., July 12th, the sale to be held in the Court House at St. Charles.

MANAGER L. W. WELLS, of the Canton (Ohio) American Gas Light and Coke Company has filed plans for a series of extensive improvements on the works at the foot of Walnut street. The old brick coal sheds along the Fort Wayne switch will be torn down and a new frame building, 175 feet long by 25 feet wide, will be put up. This arrangement will double the Company's coal storage. The Fort Wayne road will extend its switch at the Gas Company's plant to the full length of the latter's yards, increasing the track capacity also. The retort house is to be remodelled. The boilers will be removed from their present location to a more convenient place, and a new 10-inch exhauster will take the place of the 8-inch machine now in use.

AT the special meeting of the Jamestown (N. Y.) Gas Company, convened for the purpose of readjusting the capital stock of the Company, it was determined to reduce the same to $40,000 from $100,000.

THE proprietors of the Kansas City (Mo.) Gas Light and Coke Company recently presented to City Councils an ordinance asking for an extension for 30 years of the present franchise of the Company. In consideration of this extension the Company agrees to sell gas to consumers other than the city at a reduced figure, and to annually pay a certain per cent. of its profits to the city. It agrees to furnish illuminating grs of not less than 20 candle power at the rates named in the following schedule: When gas sales do not exceed per annum 250 million cubic feet, $1.50 per 1,000 cubic feet. When the sales exceed 250 million cubic feet, and do not exceed 350 million cubic feet, $1.45 per 1,000 cubic feet. When the sales exceed 350 million cubic feet, but do not exceed 400 million cubic feet, $1.40 per 1,000 cubic feet. When the sales exceed 400 million, but do not go over 500 million cubic feet, $1.35 per 1,000 cubic feet. When the sales exceed 500 million and do not go above 700 million cubic feet, $1.30; and for all sales above 700 million cubic feet $1.25 per 1,000 shall be charged, until a new schedule of rates shall be arranged. The Company also agrees to bid, as often as requested so to do by the city, for the annual contract for the supply of gas to the city for street lamps along the lines of its mains at a rate which will not exceed for each lamp, burning gas at the rate of 4 feet per hour, $16 a year, if lighted by the Humphreys schedule, or $24 a year if lighted every night one-half hour after sunset and extinguished one hour before sunrise. It is also provided in the ordinace asking for the franchise, that, after March 1, 1895, 3 per cent. of all the Company's receipts from sales of gas to others than the city, shall be paid to the city annually. This is coupled with a proviso that it shall become void at any time the city goes into the business for itself or grants a franchise to another corporation. The present schedule rate to ordinary consumers is $1.60 per 1,000, and the Company's franchise expires February 28, 1895.

MR. T. GARDNER FOSTER has retired from the position of Secretary and General Manager of the Montgomery (Ala.) Light Company, which he has held for more than four years past. Mr. Foster held the position of Secretary and Treasurer of the Montgomery Gas Light Company for more than 20 years; so that his connection with the corporation—the Montgomery Light Company, in 1889, succeeded to the rights and franchises of the Montgomery Gas Light Company—really covers the time of a quarter of a century. He will enjoy a short vacation, and then proposes to re-engage in the gas business.

IN connection with this change at Montgomery, we might also note that Mr. James A. Foster, Superintendent for the past 8 or 10 years of the Montgomery Light Company and its predecessor the Montgomery Gas Light Company, has retired from that position.

MR. A. MEYERS, Secretary and Treasurer of the Mechanicsburg (Pa.) Gas and Water Company, has completed a contract with the proprietors of the Archer gas process, whereby a plant of that type will be installed the coming summer at Mechanicsburg.

THE Boston *Herald* says that the Brookline (Mass.) Gas Company has in hand some additions and alterations to its plant on Cambridge street and Charles river in the Alston district. A new brick building, one story high and 99 by 63 feet, will be erected to contain additional gas making apparatus. The ell to the present building will be torn down and a two-story brick extension built. It will be 83 feet front by 37 feet deep. The work will begin at once.

THE American Meter Company will construct a new 14-foot station meter for the Standard Gas Light Company at the latter's plant on 115th street, this city.

THE following is an abstract of a measure under consideration by the Connecticut State Legislature, which proposes to incorporate the Banks Gas and Electric Company, of New London, Conn.:

"*Resolved*, by this Assembly, that David Banks, of the county and State of New York, Alexander C. Robertson and Charles W. Comstock, both of Montville, county of New London, with such persons as may be duly associated with them, are hereby constituted a body politic and corporate, under the name of the Banks Gas and Electric Company, and by that name shall be and are hereby empowered to purchase, receive, hold, possess and enjoy to themselves and successors, lands, tenements and hereditaments, goods, chattels, stocks, choses in action, real and personal estates of every description, and also to sell, convey, grant and dispose of the same; to sue and be sued, plead and impleaded in all courts of justice; to adopt and use a common seal, and the same to be changed at pleasure." The second section provides that the capital stock of the Company shall be $500,000, with the right to increase the same to $1,000,000. The third section specifies that the principal place of business and the main offices of the Company shall be located in New London. The fourth section authorizes the issuing of bonds not to exceed $200,000. The fifth section refers to the reception of subscriptions to the capital stock. The sixth section is as fo' lows: "Said corporation is hereby empowered to erect gas works, buildings, posts and poles, to lay pipes, to construct conduits, to run overhead and underground wires and cables, and to use all other apparatus in the town of New London and in the town of Waterford, which said Company may require for the purpose of lighting streets, parks, and public and private buildings within said territory by means of gas, electricity, or any other method of illumination, and may make and enter into contracts to furnish any kind of gas, electric or illuminating light as may be required for lighting streets, parks and buildings, and for furnishing heat and power, and for all other purposes in said towns and adjacent territory for which gas, electricity or other similar forces may be required, and enforce the same. Said Company is also exclusively empowered to put in pipes, conduits or other apparatus necessary for the production and distribution of compressed air for power or other purposes within said territory. Said corporation is also empowered to do every kind of work within said territory necessary to carry on its business." The remaining sections (of which there are six) refer to the management of the Company.

THE New York *Tribune*, of recent date, in commenting on the operation of the Broadway surface cable railroad, has the following to say respecting the lighting of the coaches, which illumination is from compressed gas, under the Pintsch system, as installed by the Safety Car Heating and Lighting Company: "They are thoroughly lighted. Indeed, it is not too much to say that now, for the first time, it is possible to read with comfort in a public conveyance at night, and the contrast is so sharp and so delightful as to make the dim illumination of other surface cars and of the elevated railroad trains doubly irritating and discreditable. If hitherto there has been a disposition to tolerate the flickering and feeble lamps which have been persistently imposed on travellers, it will be replaced by a sense of indignation at the incompetency or parsimony which keeps them in use."

THE following is a copy of the report submitted by the City Gas Inspector, of Omaha, Neb., to the City Council. It was presented on June 2d, and is well worth close attention.

To the Honorable City Council, Omaha, Neb.—Gentlemen: I visited Marysville, according to your instructions, and made a careful examination of the Harris process for the manufacture of gas. I was met at Cincinnati by Mr. Owen, who stayed with me during the test, and during the whole time every courtesy was shown me and every facility afforded for making a very good and satisfactory test. The gas is made in an apparatus differing but little from the ordinary water gas machine in use in various parts of the country. The fixing surface is so small, compared with the large amount of gas made, that it is merely carried forward as vapor. The weather was so warm during my stay that there was no condensation, so I could not tell how much of the gas was fixed and how much vapor. The gas burns with a red and smoky flame, owing to the large percentage of air contained in the gas, and is easily extinguished. It is, therefore, necessary to burn the gas in places where there is very little draft. The test of this flame on the bar photometer shows that, when the gas is burning at the rate of 5 feet per hour, it will give a light equal to about two sperm candles. This same gas, when burned in a Welsbach lamp, will give a light equal to about 32 candles. I made a number of tests in heating water with this gas, and found that 1 foot of it would cause the temperature of 6 pounds of water to rise about 52°; that is, the water would utilize about 275 units of heat that were developed by the burning of the gas. This was the average of a large number of tests, which can be given in detail if necessary. The machine is operated by blowing air and steam through a bed of fire and putting oil into the fixing chamber just beyond the fire. The gas thus made passes through the proper condensing apparatus, and goes from there into the holder. The blower is a No. 3 Root, manufactured at Connersville, Ind.—the manufacturers claim it will pass 8 feet of air at each revolution. Figuring up the air that entered into this gas, after allowing 10 per cent. for slip on the blower and 6 per cent. for the temperature of the air, I find that out of the 50,000 cubic feet of gas that went into the holder there was 39,000 cubic feet of air; or, that the air was 78 per cent. of the whole mixture. The second test lasted 102 minutes, and during this time 72,000 cubic feet of gas were made. Figuring

up the air used, in the same way as before, I find that nearly 65,000 cubic feet of air was pumped into the holder; or, practically, 90 per cent. of the whole mixture. As gas is sold all over the United States, that does not contain air, at from $1.50 to $2 per 1,000 feet, I cannot recommend that our people be permitted to pay 50 cents per 1,000 for a mixture that contains at least 80 per cent. of air. In such case the gas that they really did get would cost them at the rate of $2.50 per 1,000 cubic feet.

THE proprietors of the Matawan and Keyport (N. J.) Gas Light Company have ordered a reduction in the gas rate of 50 cents per 1,000 cubic feet. This puts the gross price at $2.50, which certainly looks to be sufficiently high.

ACCORDING to the report for 1892, of the New Jersey State Board of Assessors, the taxes paid into the treasury by the named gas companies on account of gross receipts and on dividends in excess of 4 per cent. per annum amounted to the following:

Company.	Gross Receipts.	Excess Dividends.	Total Tax Paid.
Bayonne and Greenville....	$14,599.28	$6,231.50	$384.58
Camden.....	130,318.79	9,000.00	1,101.59
Citizens, Newark.....	317,733.00	40,000.00	3,588.66
Consumers, Jersey City.....	36,000.00	None	180.00
East Newark.....	22,092.70	1,200.00	170.46
Hudson County, Hoboken...	154,728.02	24,000.00	1,973.64
Jersey City.....	77,000.00	45,000.00	2,635.00
Montclair.....	45,752.00	2,790.00	386.26
Morristown.....	30,054.32	1,600.00	230.37
Newark.....	382,225.73	60,000.00	4,911.13
Peoples, Jersey City.....	50,213.89	20,252.00	1,263.67
United Gas Improvement...	442,490.40	None	2,212.45
	$1,703,208.13	$210,073.50	$19,037.81

THE proprietors of the Youngstown (O.) Gas Company have decided to enlarge the manufacturing facilities.

AT the annual meeting of the Quincy (Ills.) Gas Company, the reports presented showed that the Company had enjoyed a prosperous year. The Directors chosen were Messrs. William Steinwedell, A. W. Littleton, J. D. Morgan, A. W. Wells, H. F. J. Ricker, Fred. Wilms and T. C. Poling. The Directors subsequently re-elected the following officers: President, William Steinwedell; Vice-President, H. F. J. Ricker; Secretary and Superintendent, A. W. Littleton.

ADVICES by way of Indianapolis, Ind., are to the effect that on June 19th the Richmond (Ind.) Light, Heat and Power Company was organized to take over the properties of the Richmond Gas Company and the electric light plant owned by Mr. J. M. Starr. The new Company is capitalized in $300,000, and the management will be vested in Mr. J. W. Roney, who will also act as Secretary. Mr. Jas. M. Starr will also be prominent in the enterprise. The electric lighting plant will be rebuilt, and a gasholder will be added to the present storage plant.

THE bid of the Camden (N. J.) Gas Company to light the public gas lamps of the city, at the rate of $19.75 each per annum, has been accepted.

A CORRESPONDENT at Toronto forwards the following: "The five consolidated actions against the Consumers Gas Company, of this city, occupied the entire attention of the Court of Assizes during June 22d. The evidence given on behalf of the plaintiffs was to the effect that the gas main on Rebecca street had burst during one night last January, and the gas had rushed into the drain pipes connected with the houses occupied by the plaintiffs, nearly suffocating 20 persons. The defence put in was that there had been no negligence on the part of the Company, that the mains had been properly laid, and that the accident to the pipes had been caused by frost. Mr. Justice MacMahon, after hearing the evidence, dismissed the jury, and held that the facts were not such as could be entertained in an action for damages."

CAN any of our readers give Mr. Bolcom "light" on the subject matter of the following query—we are unable at the present writing to solve it:

WINONA GAS LIGHT COMPANY,
WINONA, MINN., June 26, 1893.

To the Editor AMERICAN GAS LIGHT JOURNAL: There is another Richmond in the field in the shape of "a gas plant on your own hook, don't you know." The gas, as I understand it, is generated by sulphuric acid "chawing up" zinc, and then forced through crude oil, gasoline, naphtha, or something of the sort, and making a very pretty gas, at what they claim one-eighth the price we get. The fellow claims it is a new thing from Boston, "taking big." Selling rights for $1,000 a county. Found a gudgeon here; got his $1,000 and left town. Now information is asked of us. If you can give me any light on the subject I wish you would. The fellow said it was called "Electric Gas," but didn't say where or by whom the machines were made. What's the use being poor? Get a patent light, young man, and go West.—Very truly yours, H. C. BOLCOM, Manager.

THE Directors of the Citizens Gas Light Company, of Reading and Wakefield, Mass., ordered a reduction in the gross rate for gas to $2 per 1,000, from $2.50. A discount of 10 per cent. on all bills amounting to $2 per month is allowed for prompt payment. On all gas used for cooking, heating and power purposes a discount of 20 per cent. is allowed. The schedule took effect on the 1st inst.

MR. A. M. BELT, of the San Francisco Light and Fuel Company, proposes to erect a gas works at Winters, Cal. This place is in Yolo county, Cal., on the Vaca Valley and Clear Lake Railroad, at a point about 31 miles west of Sacramento.

THE new gas rate at Exeter, N. H., which is equivalent to a reduction of 20 cents per 1,000 cubic feet, is having a beneficial effect on the Company's business.

THE franchise for an electric lighting plant in Santa Monica, Cal., has been sold to Mr. J. J. Davis, of Los Angeles. He agrees to pay the local authorities the sum of $1,250 for the right, the same to be paid at the rate of $25 *annually for* 50 *years*, the time the franchise has to live. The further conditions are the deposit of $1,000 with the Town Treasurer, "as a guarantee of good faith," and the pledge that the lights are to be turned on within six months from the time of the passage of the franchise.

"OBSERVER" forwards the following from the Somerville (Mass.) *Journal*: "Cheaper gas is the welcome announcement that the Charlestown Gas and Electric Company makes to the consumers of gas in Somerville, north of the Boston and Lowell Railroad. The reduction in price will take effect July 1, when the figures will be $1.70 per 1,000 cubic feet, instead of $1.80, and $1.50 when the bills are paid within 15 days. This will make the eighth voluntary reduction in price that the Company has made since 1870. Speaking of further reductions of price, Treasurer Neal said that the Company would make reductions whenever it felt warranted in doing so. 'The price,' he said, 'is low now, and at present it would be impossible to put it any lower. Dollar gas, that there is so much talk about in Boston, whether possible there or not, is altogether out of the question in Somerville. Boston proper is the best gas consuming district in the world. It is compact; has large customers; and the fewer meters, fewer accounts, and less pipe needed makes it possible to distribute and sell gas much cheaper than in the suburbs. The price in the outlying districts of Boston and in the adjoining cities is no lower, and in some cases, not nearly so low as in Somerville. We could not sell the gas in Somerville so cheap, if it were not for Charlestown. In many parts of Somerville, there is scarcely a consumer on the street, yet we have to lay the pipes, and even then, however small the consumption, we have the same care of the meters, and the same expense of bookkeeping. Necessarily, the more and the nearer customers are, and the more they consume, the cheaper we can sell the gas, and consequently some parts of the city pay better than others. The scattered parts of Somerville get exactly the same prices as the crowded localities of Charlestown, and in that they are very fortunate. If it were not for Charlestown our business would not pay. The one thing, however, above all others, that will tend to lower the price will be the creation of a day consumption of gas, and for that reason we have been recommending the use of gas for heating and cooking purposes. Experience has shown the convenience and economy of such use, and we have every reason to think that Somerville will prove good territory as far as this matter is concerned. Coal costs a little more than it did a year ago, and that tends to keep the price from going down, and then, it may seem strange to say so, the World's Fair has some effect on the price. People are saving their money and don't pay their bills.'"

ON June 27th, under the order of the Worcester (Mass.) City Council, adopted May 29th, Mayor Marsh petitioned the State Board of Gas and Electric Light Commissioners to give a hearing on the demand of the city for a readjustment of the rates charged for gas by the Worcester Gas Light Company.

ABOUT a fortnight ago an explosion of gas caused some damage to the plant of the Rahway (N. J.) Gas Company.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

EDITOR—Jos. R. Thomas, C.E.
ASST. EDITOR—T. J. Cunningham.
MANAGER—C. E. Sanderson.

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VENTILATION, SANITARY IMPROVEMENT,
AND GENERAL SCIENCE

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AGENTS

NEW YORK.—AMERICAN NEWS CO., 39 and 41 Chambers Street.
Germany.—B. WESTERMANN & CO., of New York.

MONDAY, JULY 3, 1893.

The Market for Gas Securities.

The general share market was in a very uneven state during the week, and the speculators were very much at sea. Consolidated was sharply raided, and on somewhat free offerings sold down to 119 on Thursday. During that day 655 shares in all were disposed of in the regular way on the exchange, the range in quotations being 121¼ to 119. At the close 121 was bid, but holders asked 123. To day (Friday) the opening was made at 121 to 121¼. There is no better purchase for investment on the list than Consolidated gas. Other city shares were in slack demand, and the quotations are merely nominal.

There is no change in the Brooklyn situation, either in respect of values, which are now probably at the minimum, or in point of the deal for consolidation. There seems to be a plenty of pitch hot, as between the Equity Construction Company and the Equity Gas Company, several conferences having been held this week. It is asserted by some who ought to be in the know that the unseemly squabbles of the different parties interested are about to terminate; and we will be pleased to learn that this is the case. Chicago gas has been hammered pretty strong all week, with the result that we report it to-day at 67½ to 67¾. At these figures it is decidedly cheap. Baltimore Consolidated is at 54¼ to 55. Laclede preferred is at 55 to 59, and the common is lifeless, at 15 to 16. Bay State is very sluggish, at 12 to 12½. There ought shortly be some interesting developments in connection with this property.

Advertisers Index.

GAS ENGINEERS. Page

Jos. R. Thomas, New York City ... 25
Wm. Henry White, New York City ... 31
Fred. Bredel, New York City ... 27
H. C. Slaney, New York City ... 25
Frederic Egner & Co., St. Louis, Mo ... 30
Geo. R. Rowland, Brooklyn, N. Y ... 25
Jas. R. Smedberg, Chicago, Ills ... 25

CHEMISTS.

Durand Woodman, New York City ... 16
E. G. Love, New York City ... 20

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md ... 29
United Gas Improvement Co., Phila, Pa ... 21
Burdett Loomis, Hartford, Conn ... 31
National Gas and Water Co., Chicago, Ills ... 23
Economical Gas Apparatus Construction Co., Toronto, Ont. 20
A. M. Sutherland, New York City ... 15

GAS WORKS APPARATUS AND CONSTRUCTION.

James R. Floyd & Sons, New York City ... 31
Continental Iron Works, Brooklyn, N. Y ... 16
Deily & Fowler, Phila., Pa ... 31
Kerr Murray Mfg. Co., Fort Wayne, Ind ... 28
Stacey Mfg. Co., Cincinnati, Ohio ... 31
Bartlett, Hayward & Co., Baltimore, Md ... 29
Davis & Farnum Mfg. Co., Waltham, Mass ... 28
R. D. Wood & Co., Phila., Pa ... 30
Bouton Foundry Co., Chicago, Ills ... 31
Isbell-Porter Company, New York City ... 30
Fred. Bredel, New York City ... 27
United Gas Improvement Co., Phila., Pa ... 21
Berlin Iron Bridge Company East Berlin, Conn ... 18
National Gas and Water Co., Chicago, Ills ... 23
Frederic Egner & Co., St. Louis, Mo ... 30
Economical Gas Apparatus Construction Co., Toronto, Ont. 20

GAS AND WATER PIPES.

Mellert Foundry and Machine Co., Reading, Pa. (John Fox, Selling Agent, N. Y.) ... 33
Ohio Pipe Co., Columbus, Ohio ... 33
M. J. Drummond, New York City ... 33
R. D. Wood & Co., Phila., Pa ... 30
Warren Foundry & Machine Co., New York City ... 33
Donaldson Iron Co., Emaus, Pa ... 33
Addyston Pipe and Steel Co, Cincinnati, O ... 33

STEAM BLOWER FOR BURNING BREEZE.

H. E. Parson, New York City ... 27

GAS COALS.

Penn Gas Coal Co., Phila., Pa ... 25
Perkins & Co., New York City ... 24
Despard Coal Coal, Baltimore, Md ... 25
Chesapeake and Ohio R. R. Coal Agency, N. Y. City ... 25
Westmoreland Coal Company, Phila., Pa ... 25
J. & W. Wood, New York City ... 24
Henry C. Scheel, New York City ... 25

CANNEL COALS.

Perkins & Co., New York City ... 29
J. & W. Wood, New York City ... 24

GAS ENRICHERS.

Standard Oil Co., Cleveland, ohio ... 25

COKE CRUSHER.

C. M. Keller, Columbus, Ind ... 24

INCLINED RETORTS.

Parker-Russell M'ning and Mfg. Co., St. Louis, Mo ... 26

RETORTS AND FIREBRICK.

J. H. Gautier & Co., Jersey City, N. J ... 26
B. Kreischer & Sons, New York City ... 26
Adam Weber, New York City ... 26
Laclede Fire Brick Mfg. Co, St. Louis, Mo ... 26
Borgner & O'Brien, Phila., Pa ... 26
James Gardner, Jr., Pittsburgh, Pa ... 26
Henry Maurer & Son, New York City ... 26
Baltimore Retort and Fire Brick Co., Baltimore, Md ... 26
Parker-Russell Mining and Mfg. Co., St. Louis, Mo ... 26
Brooklyn Fire Brick Works, Brooklyn, N. Y ... 26

GASHOLDER TANKS.

W. C. Whyte, New York City ... 22
J. P. Whittier, Brooklyn, N. Y ... 29

GASHOLDER PAINT.

The Government Waterproof Paint Co., Boston, Mass ... 16

CEMENTS.

C. L. Gerould & Co., Brooklyn, N. Y ... 26

SCRUBBERS AND CONDENSERS.

G. Shepard Page's Sons, New York City ... 32
R. D. Wood & Co., Phila., Pa ... 30
James R. Floyd & Sons, New York City ... 32
Continental Iron Works, Brooklyn, N. Y ... 16

REGENERATIVE FURNACES.

Bartlett, Hayward & Co., Baltimore, Md ... 29
Fred. Bredel, New York City ... 27
J. H. Gautier & Co., Jersey City, N. J ... 27
Parker-Russell Mining and Mfg. Co., St. Louis, Mo ... 26

GAS GOVERNORS.

Connelly Iron Sponge and Governor Co., New York City ... 23
Wilbraham Baker Blower Co., Phila., Pa ... 23

GAS GAUGES.

The Bristols' Mf'g. Co., Waterbury, Conn ... 20

TAR AND CARBONIC ACID EXTRACTOR.

Geo. Shepard Page's Sons, N. Y. City ... 948

AMMONIA CONCENTRATOR.

Michigan Ammonia Works, Detroit, Mich ... 15

GAS METERS.

John J. Griffin & Co., Phila., Pa ... 34
American Meter Co., New York and Philadelphia ... 35
The Goodwin Meter Co., Philadelphia, Pa ... 36
Helme & McIlhenny, Phila, Pa ... 35
D. McDonald & Co., Albany, N. Y ... 35
Nathaniel Tufts, Boston, Mass ... 34
Maryland Meter and Manufacturing Co., Baltimore, Md ... 34
Harris Bros. & Co., Philadelphia, Pa ... 34
Keystone Meter Co., Royersford, Pa ... 35
Metric Metal Co, Erie, Pa ... 33

SELF-SEALING MOUTHPIECE DOORS.

Isbell-Porter Company, New York City ... 30
Continental Iron Works, Brooklyn, N. Y ... 16

INCANDESCENT GAS LAMPS.

Welsbach Light Co., Gloucester City, N. J ... 18

BURNERS.

C. A. Gefrorer, Phila., Pa ... 15
Moses G. Wilder, Phila., Pa ... 15

STREET LAMPS.

J. G. Miner, Morrisania, New York City ... 27
Bartlett Street Lamp Mfg. Co., New York City ... 27

PURIFYING MATERIAL.

Connelly Iron Sponge and Governor Co., New York City ... 23
Greenpoint Chemical Works, Brooklyn, N. Y ... 23
Henry W. Douglas, Ann Arbor, Mich ... 23

ELECTRICAL APPARATUS.

Wm. Henry White, N. Y. City ... 31

EXHAUSTERS.

The P. H. & F. M. Roots Co., Connersville, Ind ... 30
Isbell-Porter Company, New York City ... 30
Wilbraham Baker Blower Co., Philadelphia, Pa ... 23
Connelly Iron Sponge and Governor Co., New York City ... 23

VALVES.

Ludlow Valve Manufacturing Co., Troy, N. Y ... 15
Chapman Valve Manufacturing Co., Boston, Mass ... 15
R. D. Wood & Co., Phila., Pa ... 30
The P. H. & F. M. Roots Co., Connersville, Ind ... 936
Continental Iron Works, Brooklyn, N. Y ... 16

GAS ENGINES.

Schleicher, Schumm & Co., Phila., Pa ... 952

ENGINES AND BOILERS.

The Hazelton Boiler Co., New York City ... 17

PURIFIER SCREENS.

John Cabot, New York City ... 20

GAS STOVES.

American Meter Co., New York and Philadelphia ... 19
The Goodwin Meter Co., Phila., Pa ... 36
George M. Clark & Co., Chicago, Ills ... 17
Maryland Meter and Manufacturing Co., Baltimore, Md ... 34
The Schneider & Trenkamp Co., Cleveland, O ... 16

DIVIDEND NOTICE.

STANDARD GAS LIGHT CO. OF THE CITY OF NEW YORK,
71 BROADWAY, NEW YORK, June 9, 1893.

The Board of Directors have this day declared a dividend of one (1) per cent. on the Preferred Stock outstanding at 3 P.M., June 20, 1893, payable July 1, 1893.

Transfer books will be closed from 3 o'clock P.M., June 20, and reopen at 10 o'clock A.M., July 3.

941-3 FERDINAND McKEIGE, Secretary.

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As Manager of Gas Works in Growing Town.

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940-tf "C. N.," care this Journal.

For Sale.

The Property of the St. Charles Gas Light and Coal Company

will be sold in liquidation, without limit or reserve, for cash, at the east front door of the Court House, in St. Charles, Mo., on

July 12, 1893, at 11 o'Clock, A.M.

For Particulars address

F. EGNER, 812 Security Building, St. Louis, Mo.
JNO. A. KELLAR, St. Charles, Mo.
942-3 P. BAUER, Belleville, Ills.

FOR SALE.

Three (3) Purifying Boxes, 4 Feet 10 Inches Square, in First-Class Condition. Trays Entirely New.

Address E. C. HATHAWAY, Supt., Capital Gas and Electric Light Co., Frankfort, Ky.
940-6

FOR SALE,

Two Ten-Inch Dry Center Seals,

in good condition, and one

Small Multitubular Condenser,

4 ft. diameter and 14 ft high.
For particulars inquire of FRED. BREDEL, C.E., 118 Farwell Ave., Milwaukee, Wis.
929-tf

FOR SALE,

Two Westinghouse Engines, of 12 H.P. each.

Ten 12-inch Chapman Valves.

All in good order. Address NEW HAVEN GAS LT. CO., New Haven, Conn.
923-tf

FOR SALE,

A Set of Second-Hand Purifiers, 6 x 8 Feet,

in good order, with 6-inch Connections and Dry Center-Seal Will sell separately or together.

C. S. HAMMATT, Supt., Citizens Gas and Electric Co., Jacksonville, Fla.
937-tf

FOR SALE,

An 8-Inch Displacement Exhauster.

Address MORRIS, TASKER & CO., Philadelphia, Pa.
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To Gas Companies.

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Ammonia Concentrator.

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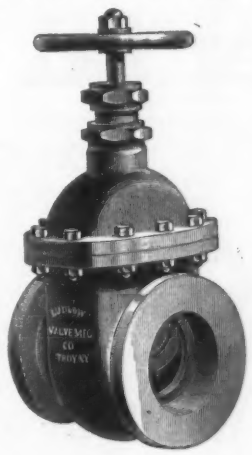

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This Generator takes but little room. It requires no change to be made in the height or depth of gas houses. It is more easily repaired when necessary. It is simpler and easier operated. It makes *more good gas from a given quantity of stock.* It makes good gas from *cheaper stock.* It makes gas of *any desired candle power* up to thirty without smoke. It makes a faultless gas from whatever gas producing materials are cheapest in the locality where required, using hard coal or coke in connection with Lima crude or any other crude petroleum or its distillates, including *Naphtha of any specific gravity.* I build these Generators with any required capacity from 3,000 cubic feet per hour upward.

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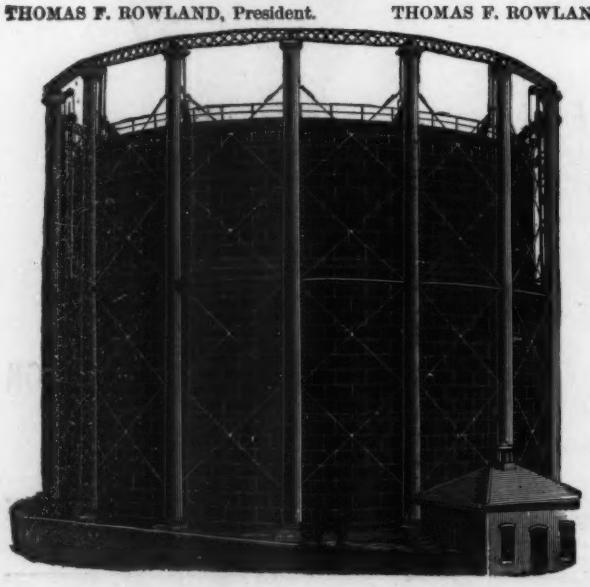

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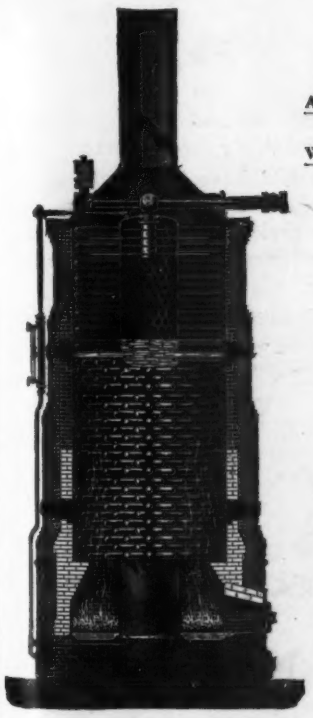

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	Candle Power.	Pressure.	Gas Consumed.	C.P. per Cu.Ft.
Average of Test No. 1,	67.05	.95 in.	2.6	25.70
" " No. 2,	63.86	1.00 in.	2.86	22.30
" " No. 3,	72.50	2.1 in.	2.87	25.26

The above averages are the results of trials on three different occasions, and in each case the mantles tested were made from a different lot of fluid.

The mantles used in the above tests were selected at random, and all had been dipped in kristaline and dried ready for shipment.

It is quite possible that better results could have been obtained by manipulating and readjusting the position of the mantles on the galleries, and also by waiting a longer period after burning off the kristaline; but I considered such fine adjustment undesirable in determining the commercial candle power.

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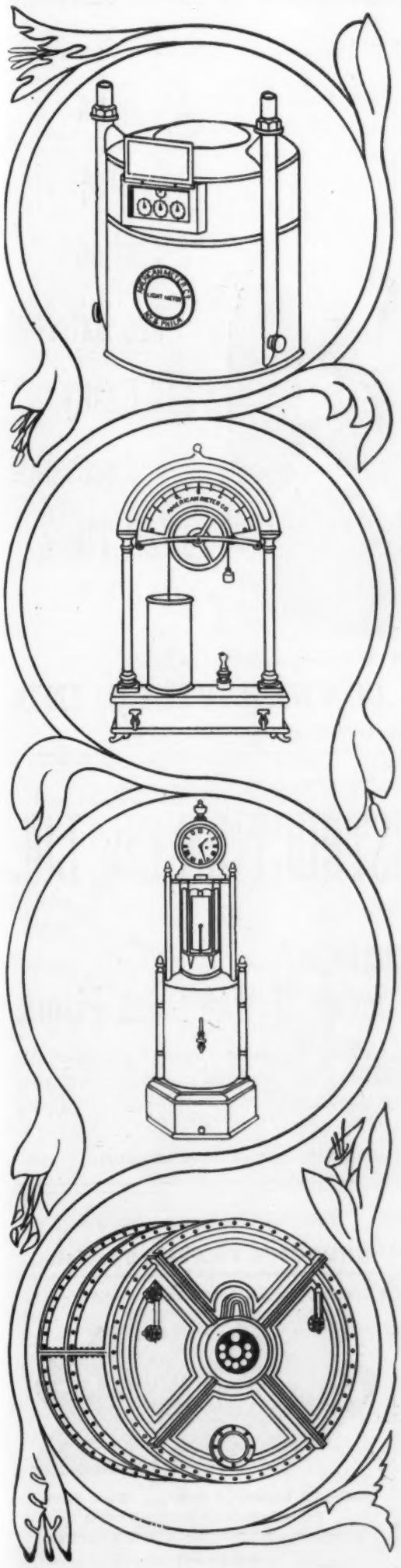

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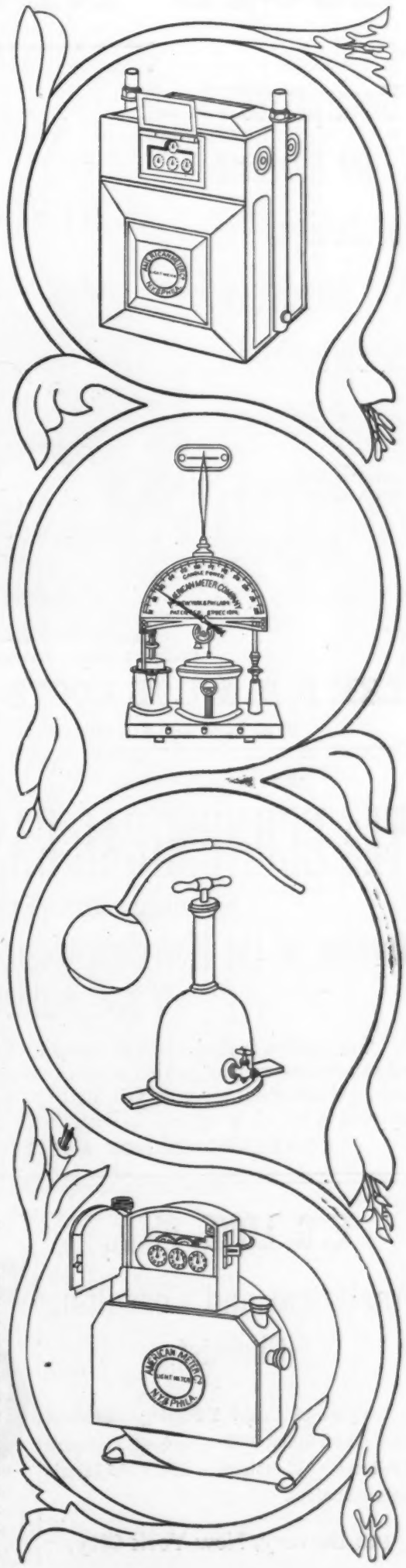
PUBLIC LIGHTING TABLE,

JULY, 1893.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P. M.	A. M.
Sat.	1	8.00 PM	10.40 PM	7.30	3.15
Sun.	2	8.00	11.10	7.30	3.15
Mon.	3	8.00	11.40	7.30	3.15
Tue.	4	8.00	12.00	7.30	3.15
Wed.	5	8.00	12.20 AM	7.30	3.15
Thu.	6	8.00 LQ	12.40	7.30	3.15
Fri.	7	8.00	1.10	7.30	3.15
Sat.	8	8.00	1.40	7.30	3.15
Sun.	9	8.00	2.20	7.30	3.15
Mon.	10	8.00	3.40	7.30	3.15
Tue.	11	8.00	3.40	7.30	3.15
Wed.	12	8.00	3.40	7.30	3.15
Thu.	13	8.00 NM	3.40	7.30	3.15
Fri.	14	8.00	3.40	7.30	3.15
Sat.	15	8.00	3.40	7.30	3.15
Sun.	16	8.00	3.40	7.20	3.15
Mon.	17	8.00	3.40	7.20	3.15
Tue.	18	9.40	3.50	7.20	3.15
Wed.	19	10.00	3.50	7.20	3.15
Thu.	20	10.20 FQ	3.50	7.20	3.15
Fri.	21	10.50	3.50	7.20	3.15
Sat.	22	11.10	3.50	7.20	3.15
Sun.	23	11.50	3.50	7.20	3.15
Mon.	24	12.30 AM	3.50	7.20	3.15
Tue.	25	1.20	3.50	7.20	3.15
Wed.	26	2.10	3.50	7.20	3.15
Thu.	27	No L.	No L.	7.20	3.15
Fri.	28	No L. FM	No L.	7.20	3.15
Sat.	29	NoL.	No L.	7.20	3.15
Sun.	30	7.50 PM	9.40 PM	7.10	3.30
Mon.	31	7.50	10.00	7.10	3.30

TOTAL HOURS LIGHTING DURING 1893.

	By Table No. 1. Hrs. Min.	By Table No. 2. Hrs. Min.
January...	217.30	423.20
February..	200.30	355.25
March	177.50	355.35
April.....	160.30	298.50
May.....	149.00	264.50
June.....	140.30	234.25
July.....	143.40	243.45
August....	154.50	280.25
September.	171.50	321.15
October....	202.20	374.30
November.	221.30	401.40
December.	248.50	433.45
Total..	2188.50	3987.45



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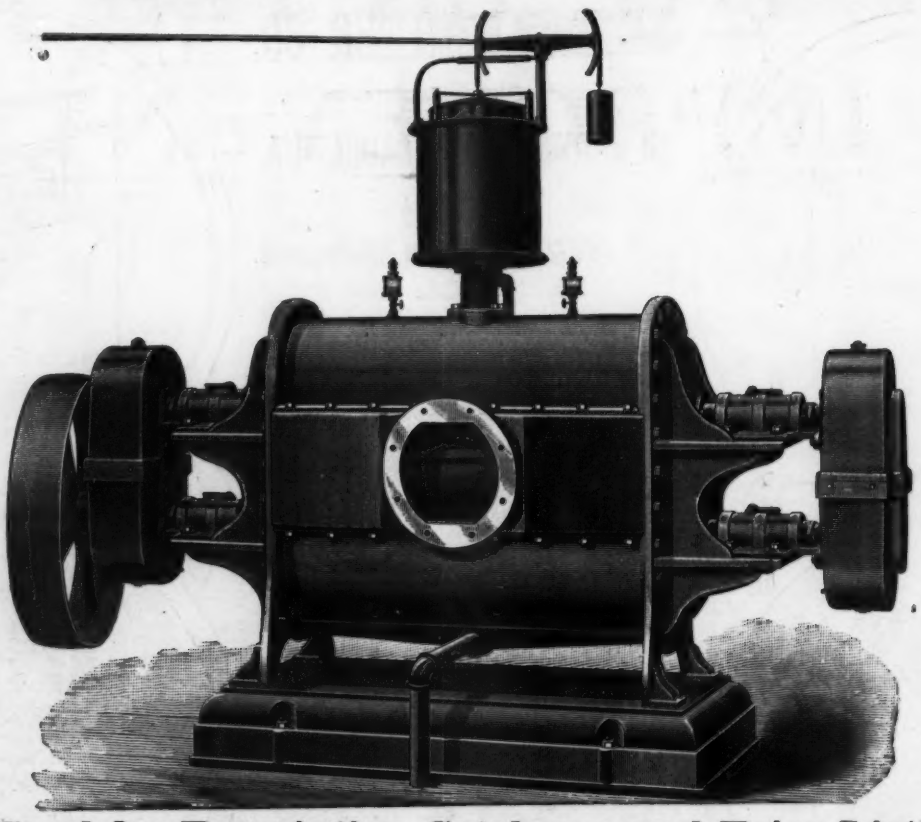

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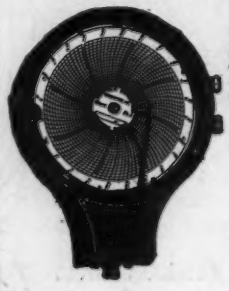

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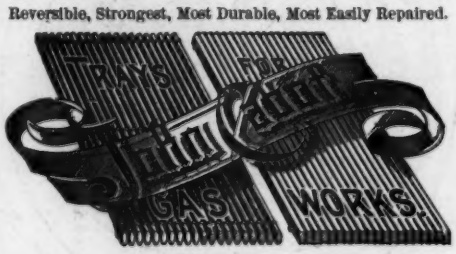

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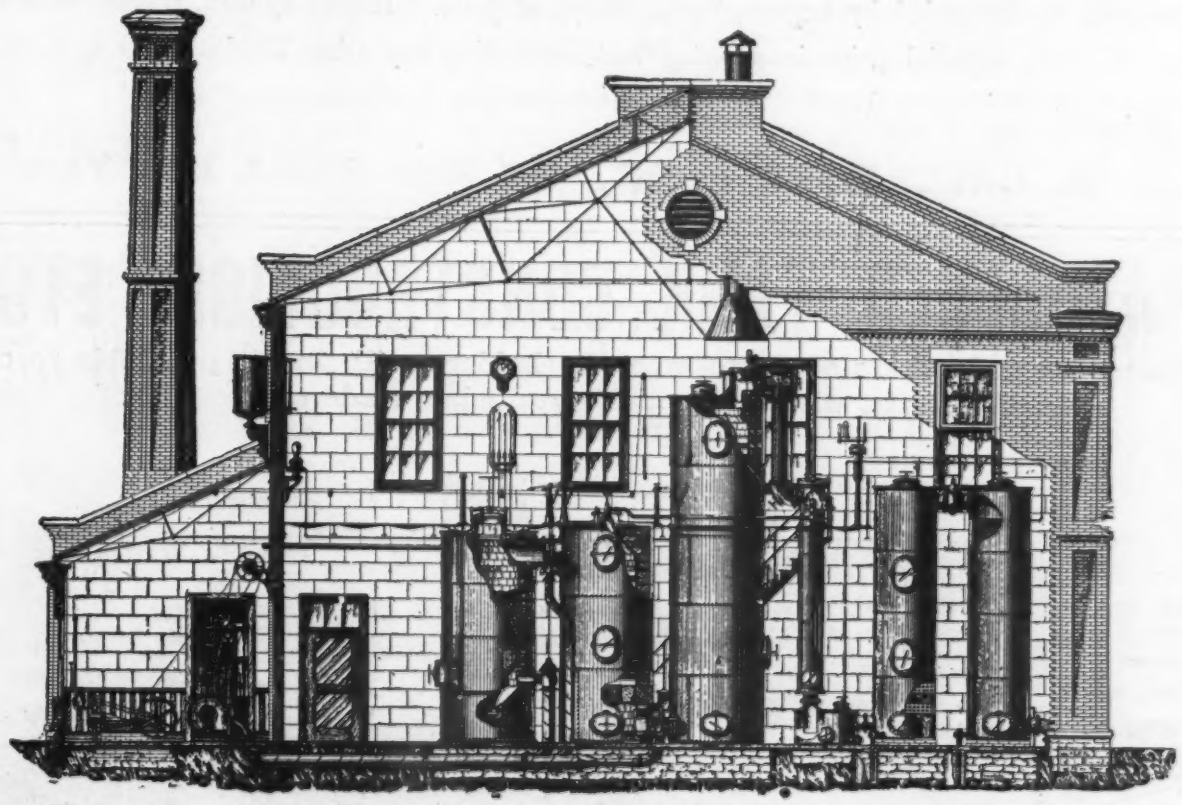

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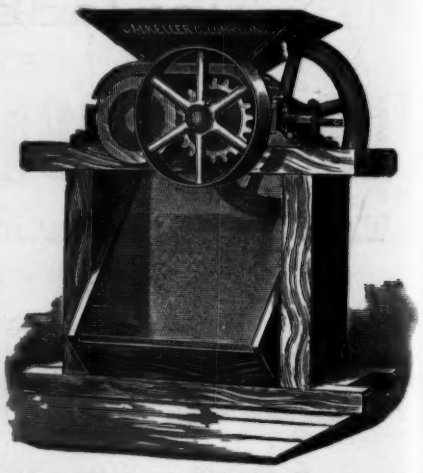

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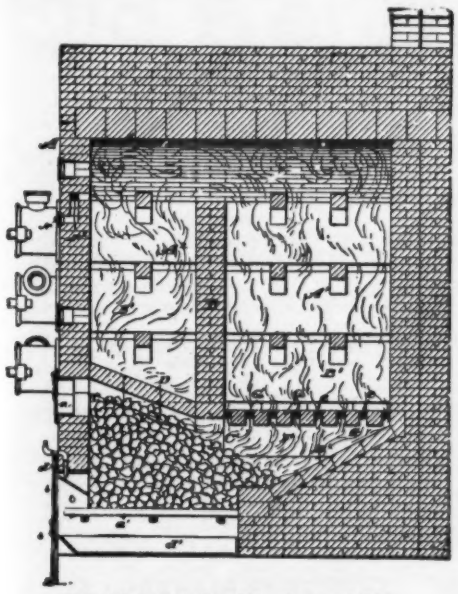

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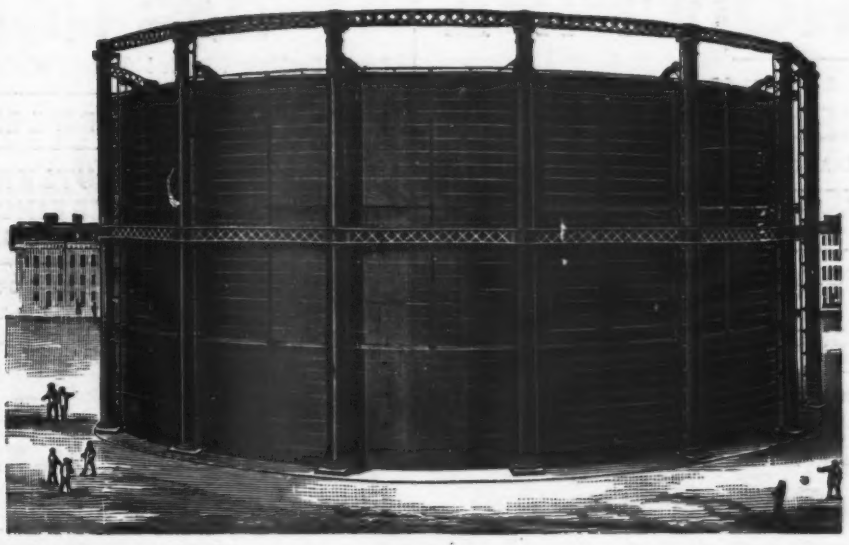

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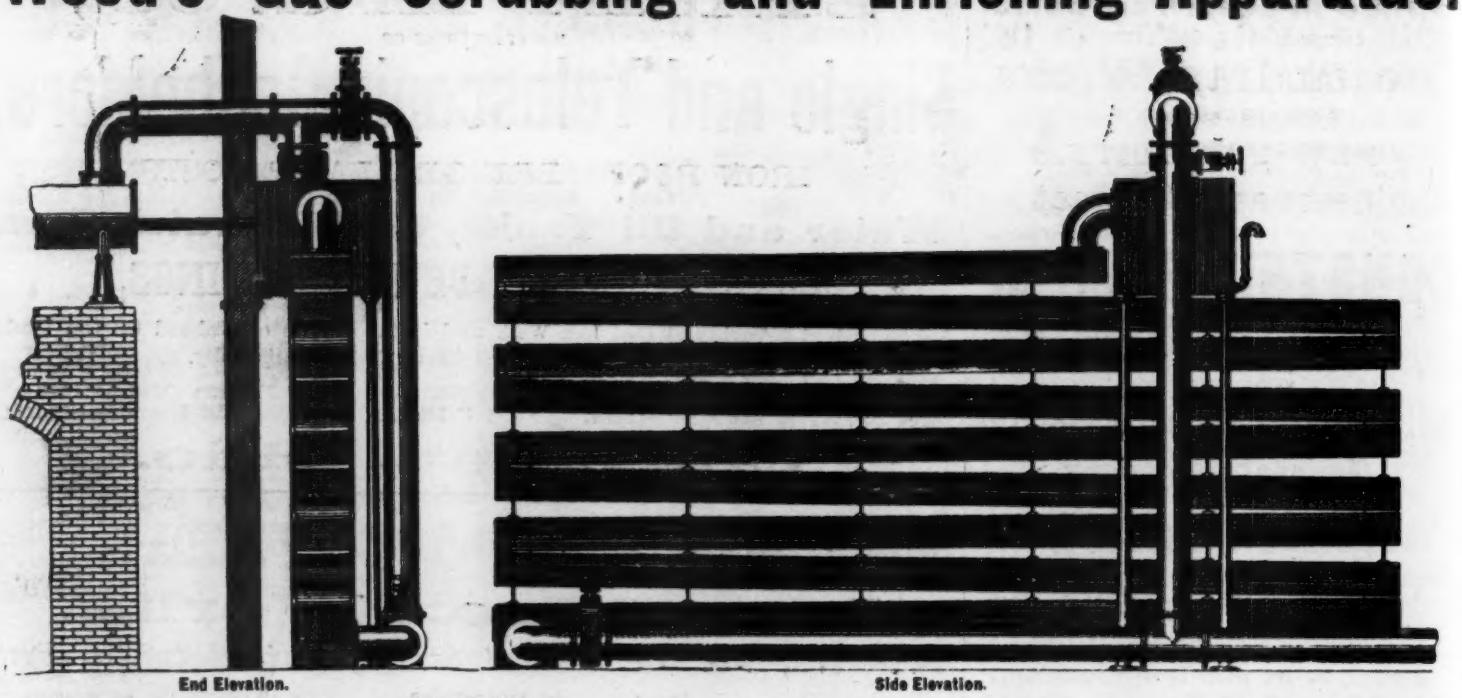

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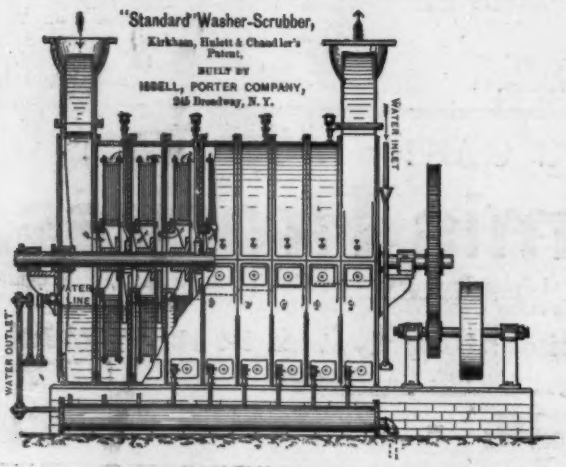

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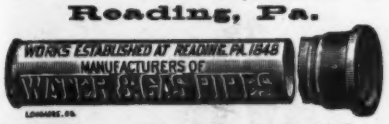

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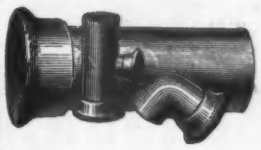

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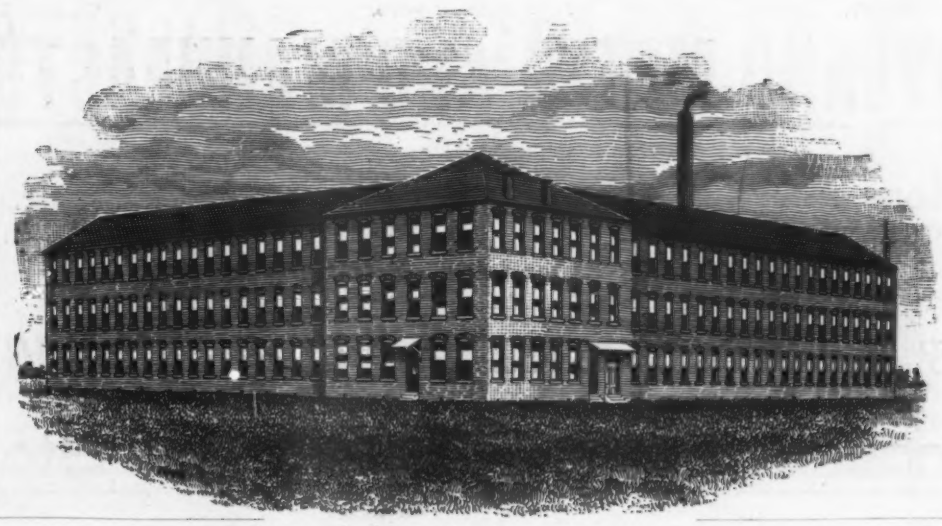

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Stove.	*Oven.*	*Broiler.*	*Top.*
31 inches high.	9½ inches high.	10 inches high.	21 inches high.
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